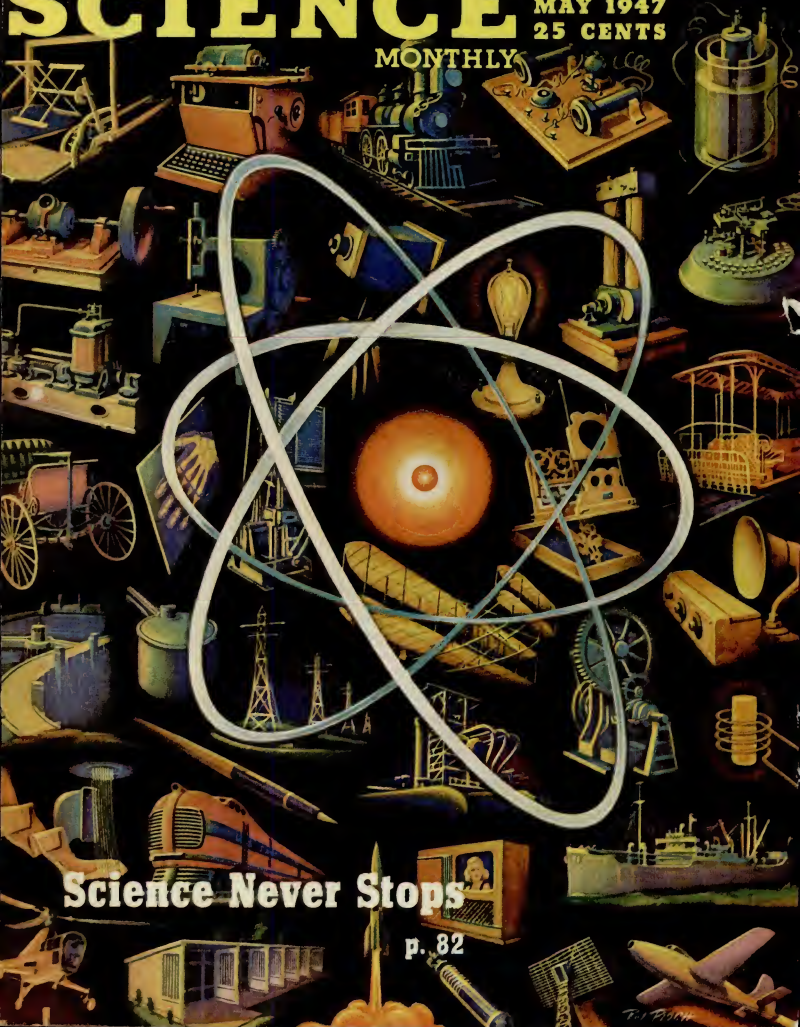


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75TH ANNIVERSARY
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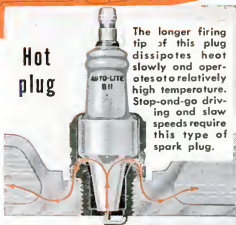
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Are your plugs wasting time and money?

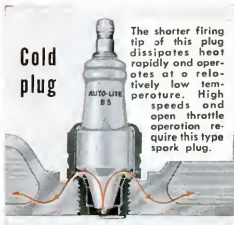
The right type of spark plug will save you time and money. Plugs which are faulty and mis-fire waste as high as 10 per cent of your fuel, according to experts. And hard-to-start engines can lose valuable time. Check all your spark plugs regularly to make sure you have the right plugs for your engines.

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The longer firing tip of this plug dissipates heat slowly and operates at a relatively high temperature. Stop-and-go driving and slow speeds require this type of spark plug.

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The shorter firing tip of this plug dissipates heat rapidly and operates at a relatively low temperature. High speeds and open throttle operation require this type spark plug.

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* Because these illustrations are not in full color, they do not accurately reproduce the actual firing tip appearance. For accurate, full color reproduction, mail the coupon.



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**"What's he got
that I haven't got?"**

LOOK at the successful men you know. "What have they got" that you haven't?

Very little, probably. In most ways these men are no brighter or naturally more capable than average. Many of them probably have no more formal education or better natural aptitudes than you.

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MAY 5
1947

Long-distance Television is twenty years old



At the 1927 demonstration, Dr. Herbert E. Ives explained the television system developed in Bell Telephone Laboratories.

APRIL 7 is a notable day in communication history, for on that day in 1927 was the first demonstration of television over long distances. Large-scale images were flashed from Washington, D. C., by wire and from Whippany, N. J., by radio to a demonstration in New York City. "It was," said a newspaper, "as if a photograph had suddenly come to life and begun to smile, talk, nod its head and look this way and that."

That was the first of many public demonstrations, each to mark an advance in the television art. In 1929 came color television, and in 1930 a two-way system between the headquarters buildings of A. T. & T. and Bell Laboratories. When

the first coaxial cable was installed in 1937, television signals for 240-line pictures were transmitted between Philadelphia and New York and three years later 441-line signals were transmitted. By May, 1941, successful experiments had been made on an 800-mile circuit.

End of the war brought a heightened tempo of development. Early in 1946 began the regular experimental use of coaxial cable for television between New York and Washington, and a few months later a microwave system for television transmission was demonstrated in California.

Transmission facilities will keep pace as a great art advances to wide public usefulness.

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POPULAR
SCIENCE



The Size of Science

THE increasing interest in science, in its facts and principles, its practical applications, and its bearings upon opinion, is undeniable. With this interest, there is growing up a new and enlarged meaning of the term.

By science is now meant the most accurate knowledge that can be obtained of the order of the universe by which man is surrounded, and of which he is a part. Science is now regarded as not applying to this or that class of objects, but to the whole of nature—as being, in fact, a method of the mind. What some call the progress of science, and others its encroachments, is undoubtedly the great fact of modern thought.

Many subjects once widely separated from the recognized sciences have been brought nearer to them. Intellect, feeling, human action, morals, all social relations—each has its basis of fact, which is the legitimate subject matter of scientific inquiry.

Those who consider that observatory watching, laboratory work, or the dredging of the sea for specimens to be classified, is all there is to science, make a serious mistake. Science truly means continuous intelligent observation of the characters of men as well as of the characters of insects. It means the analysis of mind as well as chemical substances. It means the scrutiny of evidence in regard to political theories as inexorable as that applied to theories of comets. It means the tracing of cause and effect in the sequences of human conduct as well as in the sequences of atmospheric changes.

Telegraphs, steam engines, and the thousands of devices to which science has led, are great things. But what, after all, is their value compared with the emancipation of the human spirit?

E. L. Yarnum

Editor's Note: These lines, which might have been written today, are digested from the editor's introduction to the first issue of POPULAR SCIENCE MONTHLY, May, 1872.

FO

MAY
1917



GRANDSON- OF-A-GUN

THAT cavernous muzzle staring at you is the business end of the Army Ground Forces' new 75-mm. recoilless rifle. It fires a 14-pound projectile—with sniper accuracy—at targets four miles away. Two infantrymen can carry it. One can fire it.

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The 75-mm. recoilless rifle, by contrast, weighs 110 pounds, and its tripod is the same used for the Army's caliber .30 machine gun!

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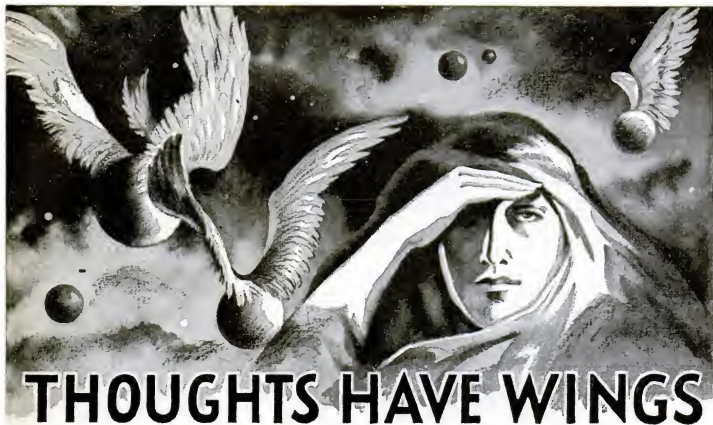
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TRY IT SOME TIME. Concentrate intently upon another person seated in a room with you, without his noticing it. Observe him gradually become restless and finally turn and look in your direction. Simple—yet it is a *positive demonstration* that thought generates a mental energy which can be projected from your mind to the consciousness of another. Do you realize how much of your success and happiness in life depend upon your influencing others? Is it not important to you to have others understand your point of view—to be receptive to your proposals?

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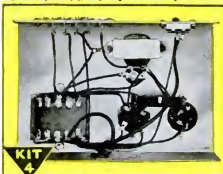
KIT 1
I send you Soldering Equipment and Radio Parts; show you how to do Radio soldering; how to mount and connect Radio parts; give you practical experience.



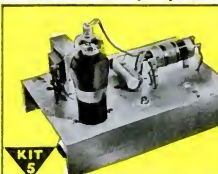
KIT 2
Early in my course I show you how to build this N.R.I. Tester with parts I send. It soon helps you fix neighborhood Radios and earn EXTRA money in spare time.



KIT 3
You get parts to build Radio Circuits; then test them; see how they work; learn how to design special circuits; how to locate and repair circuit defects.



KIT 4
You get parts to build this Vacuum Tube Power Pack; make changes which give you experience with packs of many kinds; learn to correct power pack troubles.



KIT 5
Building this A. M. Signal Generator gives you more valuable experience. It provides amplitude-modulated signals for many tests and experiments.



KIT 6
You build this Superheterodyne Receiver which brings in local and distant stations—and gives you more experience to help you win success in Radio.

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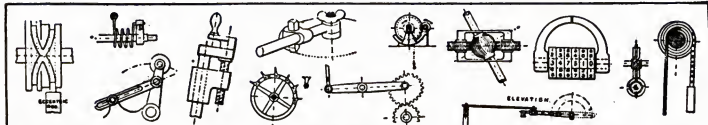
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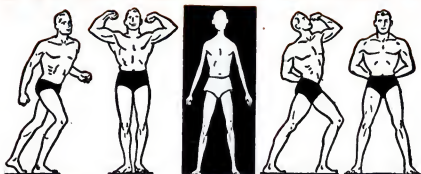
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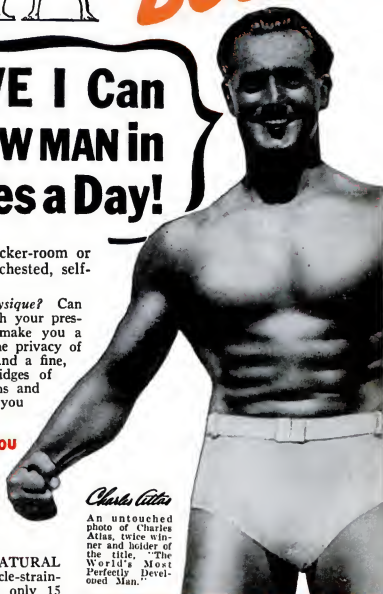
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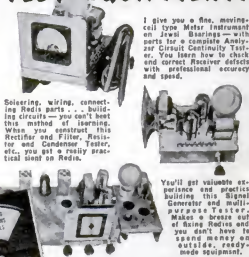


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Jerry, the talking dog, is entertaining hospitalized veterans, by courtesy of the PYROIL Company. Picture of Jerry, sent on request.

LETTERS

How Not to Drive

Sir:

That was an interesting story on how to drive tractor trailers (Mar. '47, p. 132), but I wouldn't want to ride with Champ Smith if he is going to pass a truck with another car coming, as he is doing in picture No. 5.

H. G. CRAGON

Ruston, La.

Reader Cragon, and the many others who chided Edson Smith, should give him credit for better sense. (If he didn't have it, he'd be dead, not a safety champion.) It isn't his fault that the caption writer's phrase, "about to 'take' the truck ahead," was misunderstood to mean that he was already doing it.

Treating Magnesium Lightly

Sir:

In your March article on magnesium, you state that a cubic mile of sea water contains 10 million pounds of magnesium. . . . Our physics book says there are nine billion pounds. I questioned our physics teacher about this, and he said they approximate the amounts. Did you ever hear of approximations being 8,990,000,000 pounds off?

JOHN LAWRENCE

Hazleton, Pa.

PSM wishes it could dodge as easily as the teacher did, but the Dow Chemical Co. says that the misstated approximation is even farther off than that. The figure should be 12 billion pounds.

Fumbles

Sir:

In your February article, "Edison's Magnificent Fumble," (p. 130), you mentioned that radar, using the klystron, has bounced signals against "even the moon." According to my information, the tubes used in the transmitter for Operation Diana for supply-

INVENTORS

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ing power to the antenna were a pair of 1000-T's, which are not klystrons, but transmitting triodes.

SHERMAN RIGBY

Brooklyn, N. Y.

Reader Rigby scooped up PSM's nonmagnificent fumble for a touchdown. Klystrons produce too little power to reach the moon, and are used chiefly as local oscillators in radar receivers. For the record, the Signal Corps reports that 1000-Ts were used as the transmitting tubes in the original moon contact; subsequent higher-powered transmissions were achieved by using WL530 s.

Seeing Double

Sir:

I noted with interest your March article concerning the cable fire escape from burning hotels (p. 81), for which the inventor received considerable publicity. . . . Being quite a fan of your magazine, this was nothing new to me, for if you will dig back in your files 26 years (to the March 1921 issue, p. 42, to be exact) you will find a similar article concerning a very similar device, with a photograph of its inventor. . . .

Now just what is the story on this "revolutionary" new idea of Mr. Bassett's? (Or is that Mr. Bassett as he looked in 1921, and you're running so short of material you have to print the same article twice over a period of time?)

MONROE STARK

(No address given)



1921



1947

At this late date, only Mr. Bassett, on the right, knows if that is Mr. Bassett on the left, too. PSM is as curious as Reader Stark.

Those New Fire Engines

Sir:

. . . In your January article on new fire engines, I would say that you belittle the present-day fireman, and infer: that he has

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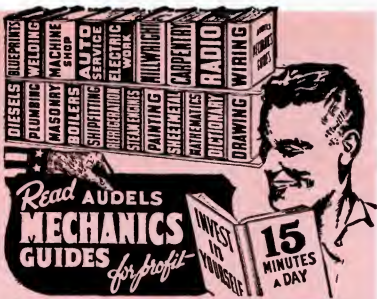
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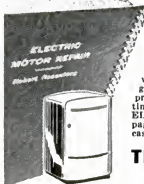
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It seems to me that in writing this article with the co-operation of the New York Fire Department, which incidentally has a well-organized department and a good drill school and officers' college, that the modern fire department could have been presented in a much better light. . . .

WALTER A. ROSSMEISL
Captain, Fire Department

Springfield, Mass.

Capt. Rossmeisl's criticism is welcomed, but he infers more than PSM said. Apparently he missed the references to aged equipment and to the volleys, who constitute 90 percent of U. S. fire-fighting personnel.

Bringing Up the Rear

Your article on "How Electric Meters Work" (Mar. '47, p. 107) is very interesting . . . but the picture shows the pointer driven directly by the worm gear on the left side. It should be on the right, and the other pointers should follow.

CLINTON SNOW, JR.

Chicago, Ill.

Right, except that the dials were shown over the rear of the meter. If you imagine the dials swung around to the front, where they always are, the gear train is in the right order. PSM's artist did it on purpose, for pictorial clarity, and carefully omitted numbers from the dials.

Deep Freezing

Sir:

I was always of the opinion that water froze at temperatures below 32°, yet you mention (ocean) temperatures of near zero 600 feet down ("Television on the Job," Feb. '47, p. 66). I would appreciate it if you would explain this.

ALBERT KRONSNOBLE

Kenosha, Wis.

The temperatures referred to were Centigrade—in other words, near freezing.

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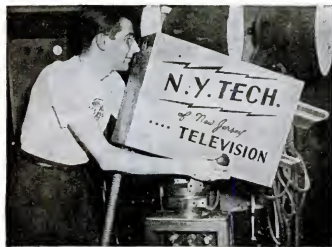


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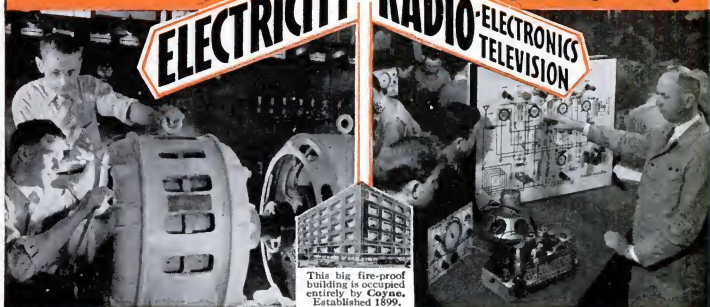
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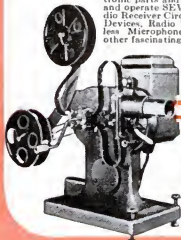
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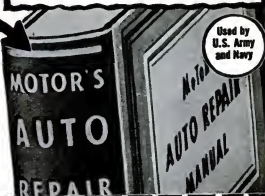


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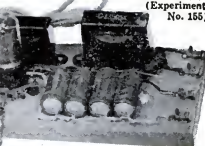
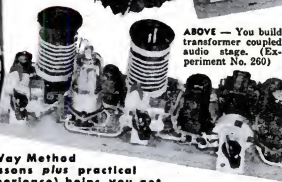
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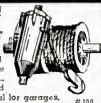
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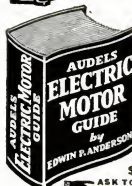
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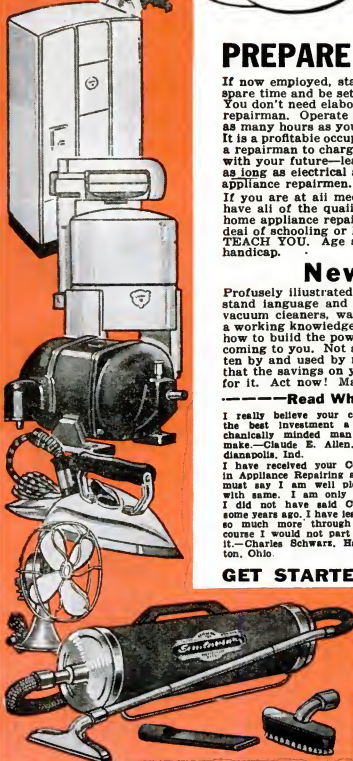
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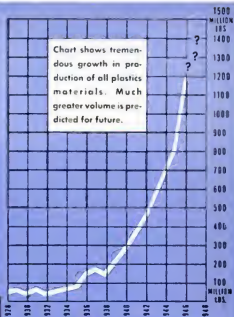
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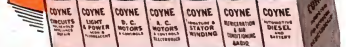
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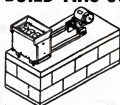
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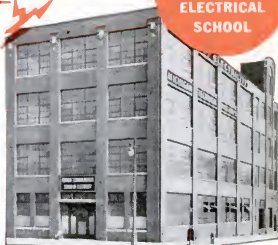
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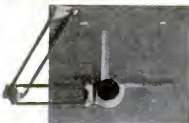
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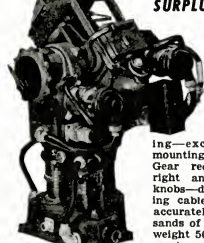
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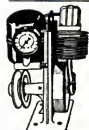


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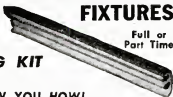
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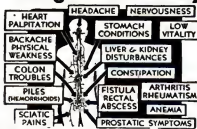
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USED-Car Handbook. "Judging the Used Car." Dealers' tricks exposed, comprehensive simple tests, photographs. Postpaid \$1. Truvalu, Box 723-C, Arcadia, Calif.

AUTO racing magazine subscriptions. Pacific Speedway News, \$6.00 yearly. National Speed Sport, \$4.00 yearly. Illustrated Speedway News, \$4.00 yearly. All give complete data midget, big car race results. Sample copy 50c. Specify publication wanted. Clymer, Dept. B-50, 2125 W. Pico, Los Angeles 6, Calif.

SPARKRITE Electronic Coil gives 25% more power, pep, & miles per gallon. Cures Hard Starting. No more dead batteries. One minute to install. Thirty day double your money back guarantee. \$5.00 postpaid. Send today! State make, year automobile. Pacific Engineering Enterprises, Box 3030, Los Angeles, California. Dealers wanted. Send for particulars.

"BUILD speedy Midget Race Tracer from castoff parts! Plans, specifications, construction information. \$1.00. Motor Supply, Box CS-1662, Toledo, Ohio."

SPEED & Mileage manual—Obtain greater speed, mileage, racing performance from any automobile! Includes simplified methods, speed tuning, gas saving secrets—Instructions on building economizers, speed equipment, duals, mufflers, superchargers, racing fuels, fast conversions. \$1.98. Alquist Engineering, 447-A 64 Street, Brooklyn 20.

13 AUTO SUPPLIES & EQUIPMENT

HAVING Car Trouble? New, Used, guaranteed auto, truck parts save money. Transmission specialist. Describe needs: immediate reply. Victory, 2930 1/4 No. Western, Chicago 18.

AUTO parts for all autos and trucks. Trans, motors, differentials, fenders, carburetors. Also Body Parts, Security and Truck Parts, 1941 BF Eddy, Chicago 13.

WANTED: complete overhead valve head—Ford-A. C. Curtis, Box 108, Shelton, Conn.

GLAZE your car twice—50c! Guaranteed! New concentrated quick, easy-to-use powder. Just mix with water. No hard rubbing. Postpaid 50c. Write for other products. 3 Star Products, 3800 Genesee, Kansas City 2, Mo.

BURN water in your car with the Vandervoel water injecting carburetor. More power, faster pickup, cleaner, cooler, smoother motor, \$22.50 complete with tank and fittings. State make and year of your car. Ralph A. Shade, 563 Lake Road, Webster, N. Y.

MANIFOLD Whistle—Imitates "Wolf Whistle", Barking Dog, Siren, Etc. Connects to any car manifold. Complete installing instructions. Send \$6.00 to Protected Company, 4033 Windsor #5, Youngstown 7, Ohio.

MUFFLER manual, Convert easily to Holley, Laguna, Westwood, duals, etc. Includes construction details, regulations, diagrams. Postpaid \$1. Mellotone, Box 723C, Arcadia, Calif.

GRILES for most all cars. Meyers Auto Parts, 820 Dryades, New Orleans, La.

CLYMERTONE Twin Muffler Sets. beautiful sound, complete with necessary welded pipes, E-Z installation. Ford V-8, \$20.00. Chevrolet set with split exhaust manifolds. \$37.50. Specify car model. Clymer, Dept. B-52, 2125 W. Pico, Los Angeles 6, Calif.

SPEEDY Piston Ringer. amazing new tool. Instantly removes, replaces any size ring. Saves time, eliminates breakage. \$3.00 postpaid. Clymer, Dept. B-511, 2125 W. Pico, Los Angeles 6, Calif.

NEON warning light operating with ignition as stop light, before brakes are applied. \$3.00 plus 30c for postage. 26 ft. ignition wire \$1.56 extra. See February Science, P. 119. Automobile Safety Light Co., 838 East 65 St., Chicago.

RACING Equipment. Cylinder Heads with Single or Dual Ignition, Camshaft grinding. Camshafts duplicated. Dual Manifolds, 160 degree 60-6 Crankshafts, w.c.s. e.c. Knepper Manufacturing Co., 504 S. Alhambra, Tulsa 4, Okla.

NEED Auto Parts? We have them. New and Rebuilt. Prompt Shipment. Write Requirements. Save Money. Buy Direct. Factory Warehouse. Mechanics Auto Parts, 3607-A North Ashland, Chicago 13.

ATTENTION! Stations. Garages Air Gun 35c; chucks 50c; deflators 10c postpaid. Box 136, Galveston, Ind.

OIL Pumping Motors—brought back to normal without ring job. Send address on Post Card for Free details. Mulliner Co., Box 3102, St. Paul 1, Minn.

CARBURETOR repair kits, gasket sets, needle and seat assemblies for most popular carburetors. State requirements. Carburetor Service, 600 LaPrairie, Ferndale 20, Mich.

POPULAR SCIENCE OPPORTUNITIES

14 AUTO TRAILERS

BUILD your own Trailer! Save Money! Have every feature you want! Plans for House, Sport, Camp and Utility trailers. Catalog describes 9 models loc. (15c in Canada and overseas). Jim Dandy, Box 125-B, Wausau, Wisconsin.

TRAILER Travel Monthly Magazine, Plant City 9, Fla. Twelve issues \$1. Sample 15c.

91 MOTORCYCLES, BICYCLES, SUPPLIES

LARGE stock Indian parts. Expert motor rebuilding. New and rebuilt Chief Motorcycle, motor only, Indian Motorcycle Sales, Kansas City 1, Mo.

WHEELS. Tires, Tubes for Motor Scooters, Midget Cars, Wheelbarrows, and Industrial equipment. All sizes, Bicycle Parts, accessories. Largest stock in United States. Send time for list. Cycle Transport Company, 1241 S. Michigan Ave., Dept. C, Chicago 5, Illinois.

WHEELS! Build wagons, scooters, mowers, trailers, wheelbarrows, grocery carts, baby cars, play pens, baby carriages, 4" to 16". Free list. Truelsen Mfg. Co., 811 E. 31, Kansas City, Mo.

MOTORCYCLE Illustrated Magazine. \$1.00 year. Anniversary Edition featuring Movie Star Motorcycle! 25c. Buzzzz, 5424-B Sawyer, Chicago 25.

BICYCLE Bargain! Brand new 1947 Schwinn or Roadmaster full size 26" balloon boys or girls only \$36.75. Send check or money order to Hollerman's Bicycle Store, 308 E. Walnut St., Kalamazoo, Michigan.

CHROME plating on motorcycle and all other parts. Silver, Gold, Brass, Bronze and Tin plating on all parts. Send check or description for prices. Master Silverplaters, 2021 Caniff, Detroit 12, Michigan.

CLYMER'S Motorcycle books, Speedway Motorcycle Racing, \$2.00. Motorcycle Speedway Annual, \$1.00. How to Make Motorcycles, \$1.50. Motorcycling Manual, \$2.00. How to Obtain Speed, \$1.50. Motor Scooter Plans, \$2.00. How to Build a Norton, \$1.50. Triumph, Villiers engines, \$1.50 each. English Motorcycle Magazine, 50c. All postpaid. See our ad automobile section. Catalog free. Clymer, Dept. B-54, 2125 W. Pico, Los Angeles 6, Calif.

HARLEY single motorcycle \$50.00, Harley twin \$65.00, complete. Motorscooters \$9.00 up, midget cars \$10.00 up, motorcycle \$25.00, less motors. Used motors \$3.00 up. Plenty of brand new 2 horsepower motors never taken from factory crates. Over 5000 bikes for sale. Scooters and small cars \$1.00 up. Mailorder only. Send 25c for Big War-Bargain Catalog Number 18, just out listing the above and hundreds of other bargains in new and used motors, motorscooters, midget cars, racers, etc. (35c by first class mail.) Midget Motors Directory, Athens, Ohio.

SCOOTER-CAR Runabout! Two passenger, three wheeled, motorized, speedy. Simple construction from available second hand parts. Detailed plans \$1.00. Midget "Jeep" plans included free. Universal, 2671 Algonquin, Toledo 6, Ohio.

MOTOR Scooters, bicycle engines, 120 miles gallon. Dime for catalog. Clymer, Desk B-55, 2125 W. Pico, Los Angeles 6, Calif.

MOTORCYCLE (miniature) lapel pins. Exact duplicates favorite 1947 model. Chromed, colorful, non-fading. Specify Harley, Indian, BSA, Norton, Triumph or Ariel, or Daytona race souvenir crossed flags. \$1.00 each, postpaid. Midget or Indianapolis race same price. Any above pins on attractive tie-clip, \$1.25; tie-folder, \$1.75. Postpaid. Clymer, Dept. B-59, 2125 W. Pico, Los Angeles 6, Calif.

BEAUTIFUL new bicycles also tricycles all makes all sizes. Reduced price list free. Atlas Cycle Co., 3002 B. Broadway, Chicago 14, Ill.

MOTORCRAFT Manual complete motorcycle, motorscooter, midget car plans, instructions, other information. 75c. Details free. Reed Motorcycle Co., 215 No. First Avenue, Maywood, Illinois.

"BUILD America's lowest priced motor-scooter speedster! Complete plans, specifications, \$1.00. Big list bargain priced used motors, etc., included free! Motor Supply, Box 1682-CS, Toledo, Ohio."

"PROFESSIONAL Midget Racer. Motor-scooter, Midget Roadster, and Midget Motorcycle. Plans, specifications for all four contained in illustrated handbook. 25c. Big list bargain priced used motors, motorscooters, Scooters, etc., included free! Midwest, 3839 Drummond, Toledo, Ohio."

"CUSHMAN motorscooter \$15. Shaw bicycle motor \$15. Harley-Davidson Motorcycle \$15! Send 50c for bargain catalog #8. Just off the press, packed with money saving bargains in motorscooters, motorcycles, midget cars, motors, wheels, tires and parts. Gail and Company, 538 Erie, Toledo, Ohio."

"CUSHMAN Motorscooter \$20 (includes motor and extra tires), Midget Racer \$15! Send 50c for Big Summer catalog #938, just printed, listing these and scores of other sensational bargains in motors, wheels, motorscooters, motorcycles. Servis-A-Motors, Inc. Associated, Box CS-1764, Toledo, Ohio."

WHEELS. Steel Disc rubber-tired for toys, wagons, scooters, etc. Sizes 5", 6", 7", 8", 10" available. United Wheels Mfg. Co., 1127 La Fayette Ave., Chicago 26, Ill.

SERVOCYCLES no more oil and gas mixing. Write for details, new lubrication system. Kalamazoo Tool Design, 337 South Burdick, Kalamazoo, Michigan.

"MOTORSCOOTERS 1947 models. Immediate delivery. Send 10c for illustrated catalog. Johnson's Motorscooter Sales Co., Milford, Ind."

15 AVIATION

AIRLINE employment interest you? Write for helpful, free information, Air Trans. Research, Dept. E, Box 1044, Kansas City 10, Missouri.

PROPELLERS—Especially designed, Air-liner 3 Blade for ice-snow sheds, boats. Also 2 Blade. Aluminum castings Ford a air-cooled conversion. Free literature. Standard Aero Craft, Ft. Worth, Texas.

VETERANS: Flight training under the G.I. Bill. Private, Commercial and Flight Instructor Ratings. Write for information, Gottschalk School of Aeronautics, Adrian, Michigan.

CAREER Counselor. Guidance for beginners. 23 years aviation experience. George Miller, 1333-18th Street, Santa Monica, Calif.

"GUNS, Wacos, Taylorcrafts, Aerocrafts. Big catalog 25c. Lists these and thousands of other sensational airplane bargains. Some are "easy to repair" crackups. National, Box 1682-CS, Toledo, Ohio."

4 AVIATION INSTRUCTION

TRAIN For Aviation Mechanics High Salaries. This famous school approved for veterans. Immediate enrollment. For information, California Flyers, Ingleswood, California.

49 ELECTRICAL SUPPLIES & EQUIPMENT

ELECTRIC Fan. Assemblies counter model, floor models, attic fans, Alaco Electric, 1430 Franklin, Saint Louis 6, Missouri.

ELECTRIC Pencil—writes, engraves all metals. Battery model \$1.00—110 volt model \$2.00 postpaid. Guaranteed 5 years. C.O.D.s accepted. Reid Industries, Dept. 265-Y, Elmhurst, Illinois.

BLOWERS, Air conditioning supplies, Gas burners. Sell for us. Card for literature. Thuman Equipment Co., 1225 Fifth Ave., St. Joseph, Mo.

ELECTRIC Pencil: Writes, Engraves all Metals. \$1.00 postpaid. Beyer Mfg., 229-C Dixon Blvd., Uniontown, Penna.

MOTORS, electric, new, 1/25 H.P., 110 volts, immediate delivery. Write for specifications. J. Fisher, 126 Richmond, Pittsburgh 8, Penna.

LAMPS—All parts to build or repair. Catalog 10c. Gyro Lamps, 5416 Clark, Chicago 40.

SELBYN motors, Bendix 3 1/2" x 5 1/2" heavy duty 115 volts, 60 cycles, \$12.95 per pair. J. A. Weber, 150A Maple, Hershey, Pa.

FANS, irons, clocks, motors, toasters, radios, etc. Jeanette Electric, 150 West 23rd St., N. Y. 11, N. Y.

HOUSEHOLDERS Attention: Repair your own electrical equipment. Detailed instructions on motors, fluorescent lamps, etc. 50 cents E. W. Lutz, 182 W. Como Ave., Columbus 2, Ohio.

WASHING Machines. Parts all makes. Northeast, Burner, 1358 H Street, Washington 2, D. C.

"GAS-MIZER"—America's finest hot water system. Dealership opportunities available. Safety Control Company, 2519 Wilson, Arlington, Virginia.

MAGNETS Alnico, New Number V stocked. Terry Sales Company, 3736 South Detroit Ave., Toledo 9, Ohio.

MANUAL On multiphase three phase induction motors \$2.00 free literature. Electric Generator Mfg. Co., 1333 N. Dale St., St. Paul 3, Minn.

ELEMENTS, Irons, Toasters, 55 cents each. Chas. Phoenix, 87 West 101 Street, New York 25, N. Y.

ELECTRIC fan assemblies. Assemble your own. Ted Riseman, 207 North Fifth, Springfield, Ill.

WIRE Recorder Magazine—Sixty minute recordings of lectures, or music reproduces and erases. Brush Laboratory made, completely assembled, chassis mounted, enclosed unit with wire spools and 10,000 feet of stainless steel wire, level-wind and brake control mechanism, elapsed time indicator, warning and stop switch, and more. Add your amplifier and motor drive for complete recorder. Price \$54.50. McCoy Sales Company, P. O. Box 335, Berea, Ohio.

140 WELDING, SOLDERING

MYRTLEWOOD Lumber 50c Bd. Ft. for turning or Furniture. Box 1, Asate Beach, Oregon.

ACETYLENE Generator. Easy to build—Plans, Instructions \$2.00. Weldox-R. 2, Box 244, Phoenix, Arizona.

NEW Model electric welder 110 volt AC-DC: Will weld all metals; easy to use, full directions. Complete with power unit, flame and metal rods, arc attachment, carbons, flux, rods, mask, all for \$19.95. Used by the Navy, Magic Welder Mfg. Co., 239-PS-4 Canal St., New York City.

WELD, Cut, Brase with gasoline! Amazing new discovery! Shatters costs. Boosts profits. Important! Write Matthews Mfg. Co., Calgary, Canada.

GUARANTEED 20 to 160 amperes output welder, uses 1/16" to 3/16" rods, with sample supplies \$135.00. New, heavy-duty industrial portable. Others, \$35.00 to \$245.00. Free illustrated literature. Williams Co., Box 4100, Portland 8, Oregon.

80 MACHINERY, TOOLS, SUPPLIES

WAR Surplus in small tools for machine shop—Send 10c for bulletin. Travers Tool Co., Dept. 5, 5 Court Square, Long Island City 1, N. Y.

BUILD Quick-change gear box without castings for \$10.00. Craftsmen, Atlas and other lathes. Complete drawings \$3.75. Stevens Engineering, 2604 Military, Los Angeles 34.

SHEBEL Saw Filer, \$75.00. Files all saws. Free trial, Circular, 730A So. 2nd St., Milwaukee 4, Wis.

POPULAR SCIENCE OPPORTUNITIES

SOCKET Wrench Sets—9/32-1/2-11/16-13/16-7/8-15/16 & 10 inch ratchet sets. High speed handle \$4.50. A. Friedman, 1514 N. Polmatista, Hollywood, Calif.

GEARS For inventors, experimenters, model makers, schools, work shops, laboratories, etc. Government surplus made of brass, bronze, dural steel and stainless steel. 12 matched pairs; 24 gears, bevel, spur and ratchet. List price \$12.00, our price \$2.50. 25 matched pairs; 50 gears, includes larger gears, also sets of worm gears. List price \$30.00, our price \$5.00. Limited quantity. Order now. Write for our bulletins on ball bearings, rectifiers, Relays, Selsyns, Horns and government surplus materials. Mail Exchange, 323 Canal Street, New York.

BRASS parts made to order on automatic lathe. Send pencil sketch for price and delivery. G. K. Keller Company, Baltimore 23.

WORK wanted for hand Turretlathe. Glesbern Machine Co., Youngwood, Pa.

DRILL GRINDER—Grinds drills to factory accuracy. Calipers with dial reading scales. Circle cutters. New Tool grinder. Lowest prices. Free literature. Factory, 811-A East 31st, Kansas City 3, Mo.

MENDALL Metal. Permanent repairs for leaks, cracks, spits, holes, in all pipe and fittings, right through. No soldering, paint. Also motors, cylinder heads, water gaskets, etc. Easy to use with blowtorch flame. Fuses with any metal at only 250 degrees of heat—less than red heat. Contains own flux. Permanently mends in ten minutes. Any part accessible to blow torch can be mended in place. Money back guarantee. Used nationally for 30 years. Send \$5.00 for 6-8 page pamphlet. Free literature. Immediate delivery. 4 A Manufacturing Co., Dept. 12, Littleton, Colo.

TANKS, Stainless Steel, 9 gallon capacity, 12" diameter, 24" long. Rated safely 400 lbs. per square inch. Internal pressure. Ideal for air compressor, rustproof tank for boat or camp. Write for details and "How To Make It" free. Surplus bargain at new price of \$8.00, job Ireland and Vice, 48 Chedel Place, Auburn, N. Y.

AIR Compressors, Electric, 3 Stage. Value over \$200.00. New 27 Volt AC-DC. Convert Easily with Transformer or 4 1000 Watts Heating Elements. Weight 28 lbs.—instructions Free. A real buy \$150. Immediate Delivery. Write For Quantity Prices—General Vacuum Co., 1439 Grand Ave., Kansas City 6, Mo.

AT last—a wire brush that really works off rust, paint or slag in a hurry. Heavy, powerful bristles. 6" Diameter. Fits any 1/2" shaft. Send for one or more of these wonder brushes today. \$1.00 each or 6 for \$5.00 postpaid. Enclose check or Money Order. Penn Electric Co., 222 Lafayette St., New York 12, N. Y.

WAR Surplus, Machines, Tools, etc. Free literature. Wayne Engineering, Greenville 2, Ohio.

MAGNETIC Dial Indicator Bases—\$3.45 Write—Eyrich, Box 849-A, Milwaukee 1.

TAPS & Dies direct from manufacturers. Equip your shop at lowest cost. Write for free price list. King Tap and Tool Co., Inc. North Attleboro, Mass.

HOBBYISTS! You can equip your workshop at a fraction usual cost by building your own Mill, Shaper, Drillpress, Bandsaw and other tools and equipment by woodworking from Lewis Castings. Materials and Blueprints. Easy to complete. Ideal for home use. Send 10c to cover cost of mailing latest Catalog describing 23 items. Lewis Machine Tool Co., 3217-S Union Pacific Ave., Los Angeles 33, Calif.

HOISTS, surplus Spur Gear Hand Hoist with lift 500 pounds and any size by famous manufacturer to lift bombs into aircraft. Easy to install and operate. New... supplied. Shipment postpaid. Write for U.S.A. for \$10.00, or write for illustrated details and dozen uses. Hurry! Ireland and Vice, 48 Chedel Place, Auburn, N. Y.

FILES—New 6" to 18". Assorted shapes 11/16, 1/2, 3/4, 1" and 1 1/2. D. & H. 1362 College Ave., Bronx, N. Y.

MACHINE shop tools released for private industry: 14" Loose Change Lathes \$150; 18"—\$180; Vertical Miller \$410; 18" Quick Change Lathe \$440; Gould & Eberhart Gear Cutter \$430; 18" lathe \$340; 2" Cincinnati miller \$460; floor type sensitive drill \$40; small hand miller \$130; Plain milling machine \$180; Medium size steel mill; Conversion Parts Co., 277 Adams Street, Boston 22, Mass.

DRILL Grinder for twist drills \$2.95. See ad on page 272.

79 MACHINERY FOR SALE

ACETYLENE Welding Outfits, new, consisting of 2 gauge Regulators, torch, 3 gas hose, connections, clamps, lighter, \$154.50. Earle Welding, Dept. 42, 5885 Broadway, Chicago 40, Ill.

17 BATTERIES, GENERATORS, ETC.

MIDOT Magnetic Motor. Small flashlight cell operators. Parts plus instructions \$30. Eltro, Deer Park, N. Y.

19 BOATS, OUTBOARD MOTORS, ETC.

FULL size, cut to shape boat patterns, blueprints, 7 1/2" x 11" feet. Illustrated "Build a Boat" catalog, 10c (in). "How to Build Boats" book, \$1.00. Cleveland Boat Blueprint Co., Dept. A-77, Cleveland, Ohio.

INBOARD marine motors, conversions, supplies. Catalog on request. Stokes Marine Supply, Coldwater, Michigan.

MARINE Power—Easily convert any Ford and Jeep motor (domestic and foreign) with Oeco parts and kits. Complete catalog \$25 (incl. Oeco Motor Corp., 2020C E. Orleans St., Phila. 34, Pa.)

ATTENTION Sportsmen! Go Kayaking! Build yours from complete, easy-construction kits. Literature. Play-acks, Dedham, Mass.

KAYAKS, Rowboats, Weldwood ready to go. Boat, E. J. Croot Co., #103-E Basking Ridge, N. J.

WHY lug your outboard motor? New easy carrier \$8.75. Catalog free. Sportsman's Pal, Tahoe Valley 4, Calif.

ANCHORS navy type, sizes 10-15-20-25-30 lb. Semi-steel, aluminum finish. Recommended size, 1 lb. per ft. Price 30c lb. f.o.b. Wilson Patterns, Coffeyville, Kansas A.S.A. Discount to dealers.

CANVAS for boats. Sailcloth, windproof, canvas cement, paints. Sails for sailboats, canoes, etc. Catalogue, Alan-Clarke, 96 Chasler, New York City.

"MARINE conversions for Ford and Jeep engines. Catalog 10c. Lehman Manufacturing Company, Department A, Newark 2, New Jersey.

RUBBER Boats—Holds 1 to 5 men; weight 4 to 40 lbs. Ideal for fishermen, duck-hunters, yachtmen, seashores. Made to rigid government specifications. Price \$14.95, \$69.75 depending upon size and condition. Write for circular. Karl Ort, Dept. PS-2, York, Pa.

KAYAK Blueprints, Deluxe Models—Catalog 10c. Viking Kanoes, Merrick, N. Y.

PRACTICAL, light, folding Kayak. Specify 10 1/2" or 15". Rush \$1.00 for plans. Kayak Sales, Dept. A, P.O. Box 1264, Indianapolis 6, Ind.

51 ENGINES, MOTORS, ETC.

"BUILD Your Own" gas drive arc welder easily with Hobart Generator. Save \$300 to \$500, and need only add used auto engine and chassis to build portable gas drive welder that goes everywhere after portable engine and generator job. Write for free instruction book, further details. Hobart Brothers Co., Box P-1066, Troy, Ohio.

MOTOR winding tester, indicates burned out or shorted coils in single or three-phase motors, indispensable for repairmen. Send for bulletin, Motor Industries, Quincy, Illinois.

150 AMPERE Generators for welding \$47.50. Extra Flexible Cable, 6 ft. lengths \$2.75. Other Bargains. Butler Electric Company, 1885 Milwaukee, Chicago 47.

ELECTRIC Motors 110 Volt AC-DC 1/2 horsepower 8000 R.P.M. (Reconditioned) Marvelous value \$6.50. Limited Quantity. B. Price, 1394 Fulton Avenue, Bronx 56, New York.

WINDING Data, listing 225 motors, single and three phase, \$1.00. Motor Data, Box 7631 Kansas City 3, Mo.

7 AMERICAN POLICE JIU JITSU

DEADLY Judo—Fiercest fighting technique. Trick knockouts. (200 photographs—plus illustrations.) Expert instructions—Three volumes. Complete \$2.25. Variety House, Box 46-A, Wall Station, N.Y.C. 5.

20 BODY-BUILDING COURSES

BAR-BELLS, Dumbbells, Exercise equipment, Courses, Free booklet. Good Barbell Co., Reading, Penna.

BARGAIN sales, Barbell Equipment, Muscle Courses. Free Strongmen Physique Circular. Write Sid's System, (C P S 10) 8421 1/2 Evergreen, South Gate, California.

1947 NEW Low Prices, Burgo Barbells, 405 Martineau, Dallas 10, Texas.

124 SPORTING GOODS, GUNS, FISHING TACKLE, ARCHERY

"AMMUNITION"—New and Used—"Shotguns"—"Rifles"—"Revolvers"—"Pistols"—"Fishing Tackle"—List 10c. Rudolph's, Atchison, Kansas.

2000 BARGAINS, firearms, binoculars, war relics, catalog 40c. Smith Museum, Runnemed, N. J.

SEND 10c for list 100 used guns. Frayseth's, Willmar, Minnesota.

BOWS—Arrows. Write headquarters for archery equipment. Quality products. Popular prices. Catalog 10c. Large illustrated Hand Book instructions, making and shooting. 50c. Archery, 617-A So. State, Chicago 6.

"OLO Lite" Bobber Release—allows bobber to slide free on line when the fish bites—35c postpaid. Olo Lite Bobbers, 2111 Woodward Avenue, Detroit 1, Michigan.

FISHING Poles, Ferrules, Guides, Tips, Clamps, etc., Native Cans, Bamboo, Tonkins, etc. Catalog 10c. Large illustrated reel-seat, butt, varnished, \$6.00. 3-Piece Native Can, Painted, \$2.50. 2-Piece Steel Rod, Guides, Tip, Hardwood Handle \$2.50. Dealers write. Bob Face, Omaha, Ark.

SPORTS Basarod Sensational Design. Lifetime Guarantee. Catalog Free. National Distributor Co. 5017-19 Cermak, Cicero 50, Illinois.

WAR Surplus—Repair Kits. For repairing Guns, Shotguns, Rifles, Radios, Electrical Appliances. Over 100 items. \$2.70. No C.O.D. shipments. Turley Sporting Goods, Brigham, Utah.

SPECIAL Sale: Hunting Knives \$1.00; Telescopes \$1.00; Compasses 35c. Under "S" Sporting Police Goods. Badges etc. Nassau Sales Co., Floral Park, N. Y.

3,000 BARGAINS—Antique Firearms, Indian Relics, Coins, Minerals, Flintlocks, Rifles, Pistols, Swords, Cartridges, Fossils, Illustrated Catalog 25c. Holke, Wrentham, Ill.

AMERICA'S most fascinating hobby. Collect famous American and foreign train emblems, 77 selections. Airlines, Railroads, Steamships, Hotels. See page 112 March Popular Science. Free introductory package, plus Free Baseball sticker, 25c. Samples 10c. "Traveler" c/o Vogue Specialties, Carnegie Hall, Cleveland 15, Ohio.

POPULAR SCIENCE OPPORTUNITIES

55 FIELD GLASSES, TELESCOPES, ETC.

REFLECTING Telescope, complete 3 1/2" diameter, equatorially mounted. View planets, stars, \$19.75. Write SkyScope Co., 475-58th Ave., New York.

60 POWER telescope, \$2.95. 250 power microscope, \$2.45. Send for free catalog of Telescopes, Binoculars and Microscopes. Brownscope Company, 24 West 45th Street, New York.

FOR Sale: 6 x 30 and 7 x 50 Binocular optics. Fine quality. Cemented doublets. All optics coated. 6 x 30 ... \$8.50 complete set. 7 x 50 ... \$12.50 complete set. Mail Your Orders Today, Mitchell Optical Co., 236 East Monroe, Kirkwood 22, Mo.

INFRA-RED filters glass 1 1/4" (40 mil) diameter, mounted. Snap on binocular or camera. \$1.00 per set. Ross, B88 West Broadway, New York, N. Y.

GENUINE polaroid glass—2 1/8" (72 mil) diameter. \$1.25 each. 2 x 2" (40 mil). Ross, B88 West Broadway, New York, N. Y.

MAKE high power reflecting telescope, complete kit of precision optical parts fully finished: 3" diameter, 44" focal length, mirror and diagonal both hard aluminized, plus 3 lenses for high power. Rubbles. The buy of the year. All \$6.00. Ross, B88 W. Broadway, New York 7, N. Y.

TELESCOPES, Microscopes, binoculars, barometers, books, photographic equipment; Buy, sell, repair. Lists 10c. Rasmussen & Reece, Amsterdam, N. Y.

MAKE your own powerful, efficient astronomical telescope. Lenses and instructions 100X \$2.50, 200X \$3.50, 400X \$5.50. Instructions alone 10c. Carl Jamer, Manville, N. Y.

MAKE your own efficient compound microscope. Lenses and instructions \$1.00, 200X \$2.00, 400X \$3.00. Instructions alone 10c. Carl Jamer, Manville, N. Y.

43 DOGS, BIRDS, PETS, RABBITS

ANGORAS, Chinchillas, White Giant Rabbits—"Rabbitry" magazine sells everything. \$1.00. Self-cleaning Hutch plans \$1.00. Automatic Feeder plans \$1.00. All three \$2.50. Catalog sent. Pedigreed Rabbits free! Grinsteins, Dept. 16-D, Edwardsville, Ill.

RAISING Rabbits, Cavies, Hamsters, Chinchillas is a growing and profitable industry. Magazine 10c. Descriptive Book and magazine 25c. Book and magazine (monthly) one year \$1.00. Address Small Stock Farmer, Pearl River 16, N. Y.

GUARANTEED Chin-Chin Giant Chinchilla rabbits. Greatest amount of delicious meat. Largest, finest, most valuable stock. Tremendous demand for breeding stock. We buy youngsters. Contact world's largest breeder, Wool Brook Farm, R16, Sellersville, Pa.

RABBITS for Fun, Food, and Fur. New Zealand White breeding stock. Easy to raise. Instructions free. Hazebrook, R 5 C, Gettysburg, Pa.

\$250 MONTHLY. Raising Angora Rabbits. Particulars free. White's Rabbitry, Lawrence, Kansas.

REAL Giant Chinchilla Rabbits. Offered by their originator. Free details. Stahl, Pearl River, N. Y.

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"HOW To Break And Train Horses"—A book every farmer and horseman should have. It is free; no obligation. Simply address Beery School of Horsemanship, Dept. 685-C, Pleasant Hill, Ohio.

POPULAR SCIENCE OPPORTUNITIES

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ART Photos of Beautiful Hollywood models 4 x 5-8 for \$1.00, 32-\$3.50 Pre-paid, Visual Slides, 1289 Broadway, New York 1.

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MEXICAN Law General Practice Atlanta, 1203 Arizona St., El Paso, Texas.

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PERFORM astounding stunts with Alnico. Dely gravity. Mystify your friends. Two bar magnets, (4 oz.), instructions, \$6.00 Postpaid. Ross, 368 West Broadway, New York, N. Y.

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LOOK AT THESE LOW RATES

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Enclosed is \$..... Word Count.....

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Name.....

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Brand new, guaranteed
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Each.....
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Of fine heavy
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roomy pockets with snap
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Practically acting
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Brand new.
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Brand new! Top
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12 inch seat.
Hair grip.
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and saddle loops.
real buy for
a horseman. Worth much
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A145. Each.....
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Genuine wishbone
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Nickel-plated brass.
A102 Pair.....
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per set of
four.....
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New 2 piece rain suits.
Of durable wear resisting
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Jacket has parka at-
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Small, medium and large
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Brand new gov't. surplus.
Army-Navy model. Single
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Silver colored dial. A
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Highest quality with chrome plated frame; 3
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Fifty records of modern dance, race, blues and
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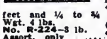
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For hunters, fishermen, scouts.
Waterproof and transparent. Use it
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Has screw cap top for
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Hundreds of uses.
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Each.....



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A shatterproof, welded
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causes listed above.
Measures 6 1/2 in. in.
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1.4 cu. ft. Has 3/4
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Shp. wgt. 2 lbs.
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For your car, boat, farm-
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with clinched
edges for flush
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The 3 pound
all provides
approx. 45
pieces in
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4 inches to 3
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Wt. 4 lbs.
No. M-224-3 lb.
Assort. only.....
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Of heavy canvas webbing. Ad-
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Used by perfect.
Wt. 2 lbs.
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Fine forged steel. Ground but
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Will take and hold a fine edge.
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Regulation two piece
Army Mess Kits with
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Plastic screw top closed
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Heavy canvas. Button fastener.
Wt. 2 lbs. No. A301.
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Two yard,
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Has water-
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to-proof nylon
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Let's you sleep outdoors
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construction. Originally de-
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Regulation
Army type
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ropes, etc. Of
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Ideal for outdoors-
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Worthwhile gift for children.
Wt. 3 lbs.
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Television—a Season Pass to Baseball !

Every home game—day or night—played by the New York Giants, Yankees and Brooklyn Dodgers will be seen over television this season!

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Those who own RCA Victor television receivers will enjoy brighter, clearer, steadier pictures through the exclusive RCA Victor Eye-Witness

picture synchronizer that “locks” the receiver in tune with the sending station. For television at its finest, you’ll want the receiver that bears the most famous name in television today—RCA Victor.

When you buy an RCA Victor television receiver or radio, or Victrola radio-phonograph, or an RCA Victor phonograph record or a radio tube, you know you are getting one of the finest products of its kind science has yet achieved.

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Several television cameras bring you a close-up of the action wherever it occurs. Here are two RCA Image Orthicon television cameras used by NBC's New York station WNBT in televising home games of the New York Giants.



RADIO CORPORATION of AMERICA



EDWARD L. YOUMANS

**POPULAR
SCIENCE**
MONTHLY

The Editor's Job

1872...1947

*A statement by the publisher
of Popular Science Monthly.*

WHEN Edward Livingston Youmans was the editor of this magazine, there were no such things as the long-distance calls, linotypes, half tones, high-speed color presses, airplanes and teletypes that fill the days of Perry Githens. But the present editor shares with the first editor the same conviction: that science is not only the concern of star-watchers and laboratory hermits. Today, in fact, science is more than ever what Youmans called it: everybody's business. In the past 75 years science has emerged from the library, through the laboratory, into daily use in our houses and industry. And it is this basic belief, I think, which has kept *Popular Science Monthly* growing for three-quarters of a century.

Seventy-five years have changed PSM physically from a magazine of words to a magazine that delivers its message with a liberal use of illustrations as well as articles from authorities in their fields; nine hundred issues published have sharpened it editorially. Youmans solicited his manuscripts from the scientists, pleading with them to put their ideas into plain people's language. Nowadays, science has become an important subject in every kind of magazine and news-

PERRY GITHENS



paper. There has evolved a whole new body of scientific journalism.

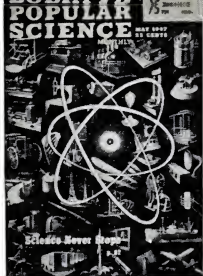
Today, with a circulation of more than a million, Githens arouses his readers to awareness and understanding of the complex world about them. He must anticipate their timely interests with a journalistic approach almost as breathless as the morning paper. He must take his readers inside the things and situations, big and small, which affect their living.

To do this more complex job, today's editor has a large permanent staff of professional writers, artists and photographers, plus a corps of specialist contributors. For everything that goes into this magazine must be specially fitted to the needs of its readers.

But the purpose of PSM has never changed. And the techniques of ideapresentation originated by Youmans are still used, with the added force of modern methods for the speedy and colorful dissemination of ideas on paper.

Godfrey Hammond

MAY
1947 81



Painting by Ray Ploch

*The world has made vast strides
in the last 75 years; even greater
triumphs lie ahead if mankind has
the courage to go on with the job.*

Science Never Stops

By Harland Manchester

Illustrations by John Gaydos

MAN, standing upon the eminence of 1947 and gazing into the future, may well be dazzled and also perplexed by the promise of science to redeem his world. New discoveries and improved techniques on a hundred fronts present golden chances for a richer and fairer existence—if man has the sense, the honesty and the guts to seize and exploit them for the good of all.

Science is a blank check, and this is no time to be niggardly in filling it out. There are, of course, the doubters, like the 19th-century patent commissioner who wanted to close his office because nothing remained to be invented. If these timid souls look about them, they will see men and women who were living when there were no telephones, electric lights, automobiles, airplanes, radios, motion pictures, antitoxin serums or anti-septic surgery, to mention a few advances of the last 75 years.

Modern techniques have shortened the time lag between the original idea and its practical application. Today's machines and methods, which amaze oldsters, may be nothing compared with the parade of triumphs soon to come.

There will be many discoveries and feats of engineering that we cannot foresee, but if we consider the significant projects now under way and the world's most obvious needs, we can reasonably make an informed guess as to the shape of things to come.

AT THE top of anyone's "future list" stands the great question of atomic energy. Will the splitting atom bring a millenium of cheap power, supplanting oil and coal? At present there are two answers: a short-range program based on actual knowledge, and distant possibilities based on audacious hopes.

Many corporations, aided by the country's leading scientists and engineers, are now working on projects to apply the energy of the splitting atom to stationary power plants,

THE COVER: Left to right, top to bottom—early McCormick harvester; Remington Type-Writer; wood-burning locomotive; early telephone; "wet" battery; Edison tinfoil phonograph; Singer sewing machine; early camera; Edison incandescent lamp; dynamo; telegraph printer; steam turbine generator; Duryea auto; X-ray; first linotype; stereoscope; streetcar; Boulder

Dam; pressure cooker (symbol of light metals); high-voltage power line; Wright airplane; early radio; nylon; Diesel streamliner; fountain pen; petroleum cracking plant; machine tool; induction heating; helicopter; prefab house; V-2; television; steamship; hypodermic needle (symbol of vaccines, sulfas, penicillin); radar; jet plane; over all: the symbol of atomic energy.

ships, guided missiles and planes. Atomic power plants at Hanford and Oak Ridge will be in operation within a year or so. That project is simple. Heat and power are interchangeable, and every hour the Hanford pile turns out heat equal to that obtained from burning 7,100 gallons of fuel oil or 38.5 tons of coal. This heat can be used to make steam to drive turbines, or, more efficiently, to heat mercury vapor that will drive a turbine and then make steam to drive a second turbine. This mercury-steam combination (now used in coal-fired plants in Kearney, N. J., Hartford, Conn., and Schenectady, N. Y.) is the only prime mover known that gets as much power from its fuel as the Diesel, long the yardstick of superior efficiency. It may be still better to use the heated air from the pile to drive a gas turbine of the closed-cycle type, in which the hot air constantly recirculates, and heat wasted through the exhaust in the open-type gas turbine is used to make more power. Since radioactive air may eat away the turbine blades, helium, which cannot be "poisoned," may be used in this efficient engine.

That brings us to one of the greatest problems of atomic power—radiations that cause falling hair, sterility, wrecked red corpuscles and often lingering death. A wad of paper will stop all the charged particles caused by nuclear fission, but two uncharged criminals—gamma rays (akin to X-rays) and neutrons—must be caged by heavy shields of lead, concrete or other dense material. Nuclear physicists all over the world are seeking a lighter, more compact shield. We can reflect heat radiations with a thin sheet of aluminum instead of absorbing them with bulky insulation, and we can bend light rays in a lucite pipe and send them back where they came from. If these facts offer any clues, we can be sure that they are not being neglected.

Until lighter shields are discovered, atomic power as we now know it can be used only in stationary power plants, ships, locomotives, rockets and pilotless planes. There is no evidence yet that it will be much more economical than power methods now used, but it might bring all the blessings of a TVA to a region without coal or water power, and it might enable an aircraft carrier to circle the world a few times without refueling.

But if we persist in harnessing the atom to our present engines, we will copy the

early motorcar makers who mounted gasoline engines in buggies. A great goal seen by scientists is the direct conversion of atomic energy into electric power without routing it through the cumbersome heat cycle. How about some method of inserting metal terminals in a uranium pile and drawing electric power as you would from a



battery? (Forecast by Dr. J. A. Hutcheson, Westinghouse Research Laboratories.) Can we use high-vacuum insulation to build small electrostatic generators like the giant Van De Graaff atom-smasher, enabling us to use directly and conveniently the energy of nuclear fission? (Suggested by Prof. John G. Trump, of MIT.)

So far, our atomic power has come from smashing the heavy atoms U-235 and plutonium, but the sun gets its power by combining little atoms of hydrogen into bigger ones of helium. Man may learn to do this, with an increase in power of about 1,000 percent. Or scientists now investigating the cosmic ray in this country and in Russia may learn its trick of disintegrating hydrogen atoms. No one can scoff at the notion that some day the world's work may be done by atomic-power engines of sizes suitable for every job, fueled by elements that are abundant and cheap. In any event, science will press toward that goal. We have entered the lair of the atom, God help us, and the door is locked behind us. There is only one way to go.

WHILE we are waiting for atomic power, scientists and engineers will have their hands full perfecting new fuels for our present motors as the oil wells run dry. The world's petroleum supply is definitely dwindling, and new deposits will be increasingly expensive to work. But we have enough coal for an estimated 2,500 years, and from

coal and natural gas, as the Germans have shown, we can obtain gasoline and Diesel oil, as well as by-products of fuel gas and alcohols. Coal, the orphan of research, will soon come into its own at the hands of the "long-haired professors" whom the short-sighted mine operators long disdained.

For several years a toy refinery has been operating in the laboratories of the Bureau of Mines in Pittsburgh. Coal goes in at the top and gasoline trickles out at the bottom. Now two full-scale plants are being built in Texas for making motor fuels from natural gas by the more efficient Fischer-Tropsch process. The next step is to use coal to make the gas to make the gasoline, and several big oil companies are spending large sums in research to have this method ready when it is needed. The cost of gasoline from coal abroad has always been high compared with U. S. filling station prices, but improved methods of making cheap oxygen (developed by Dr. Kapitza, of Russia; MIT, and M. W. Kellogg and Co.) will help in making synthetic fuels at prices we can pay.

You don't have to turn coal into oil to provide a convenient fluidlike fuel. You can pulverize it as fine as face powder and blow it into the combustion chamber of a gas turbine. Perhaps tomorrow's Iron Horse will grind up any cheap coal, burn it, remove the fly ash, and spin a turbine with the hot gas, getting three or four times as much power out of the coal as does today's steam loco-

the fuel gas as it comes up another pipe? (Now done experimentally by the Alabama Power Co.) If oxygen becomes cheap enough, it could feed the fire to make richer gas, which might be distributed through pipe lines like oil, or burned at the surface and converted into electric power.



That brings us to another great need—an efficient method of transmitting electric power over a thousand miles. However it may be arrived at, power decentralization is one of America's most important goals. Aside from a military value that we hope will not be tested, it should contribute immeasurably toward promoting freer competition and providing more living space and recreational opportunities for everyone.

THE man of 40 will live to be flabbergasted by new strides in transportation. Before long, robot planes with recording instruments will probably penetrate the transonic speed barrier, that mysterious region lying between 650 and 950 m. p. h. Will these pioneers pave the way for human flight at 1,000 m. p. h. or better, and if so, what motors and airfoils will be used and how will they behave at a slowpoke 400 m. p. h.? Planes have already reached speeds that rival the pace of their own bullets, and pilots who bail out have to be blown from their seats by explosives. There will come a time, determined by the length of the average journey between points on earth, when further speed will not pay. If you're going on a quarter-mile errand, you don't step up your car to 80, and we can apply such a formula to air distances and speeds.

The future of really fast travel lies in the waste spaces of the heavens. A V-2 rocket has already been sent up 114 miles (White Sands Proving Ground, Dec. 18, '46), and as Dr. Fritz Zwicky puts it: "We first throw



motive. (Built experimentally by John I. Yellott of the Locomotive Development Committee, Baltimore.) There is no reason why this engine can't be used to drive ship propellers and factory wheels.

But why mine coal, haul it to factories, pollute the air and run up laundry bills? Why not burn it where it lies, pumping air down a pipe to keep the fire going, and collecting

a little something into the skies, then a little more, then a shipload of instruments—then ourselves." Restless man will probably throw himself at the moon, at Mars, and at other chunks of matter and return to write books about it. Experts report that it's only a matter of mathematics, but first a few problems must be solved. While man's body can safely travel at any known speed, with too sudden a change in speed or direction his more easily detachable components, like blood and entrails, proceed in an opposite, or tangential, line of march. The more efficient a rocket is, the more likely it is to annoy its crew in this manner, since it must lighten its fuel load by quickly turning it into driving energy. This may cause acceleration too rapid for health. A compromise is indicated, and research toward creating new fuels that will give more power per pound. If lightweight shields against radiation are discovered, atomic power may bring about interplanetary travel.

To serve man best, earth-bound aviation will concentrate on economy, convenience and safety, with safety first. We have an array of tools—Ground Control Approach, Instrument Landing System, Loran, fog-dispersal methods, to name a few—that in some combination should make blind flying about as safe as taking a bath. For convenience, we need among other things a reliable low-priced helicopter. Maybe it will be driven by jets mounted on the tips of the rotors. Such a machine may sometime supplant taxicabs, ambulances, fire engines, cow ponies and crop sprayers.

NEWLY developed tools for communication, when fully applied, will match comic-book dreams. Just now we are beginning to move radio broadcasting from the noisy, crowded, low-fidelity AM band upstairs to FM, where music sounds the way it's made and there is room enough on the air for thousands of stations instead of hundreds. The transition should be virtually complete in a few years. Beyond that lies a time when telephone and telegraph poles will be sold for firewood, and microwave relay networks (used experimentally by A. T. & T., I. T. & T., Western Union, General Electric and Raytheon) will cover the country, using wave lengths a few inches long to carry all oral and visual intelligence, including FM broadcasting, phone calls, telegrams, television and facsimile.

By means of such a co-ordinated system,

a general in the Pentagon could throw on his office screen radar scopes in any part of the country and see what planes are in the air, and the telephone band could be so wide that every house in a city of 10,000 could have its own radiophone wave length. (Predicted by Dr. M. H. White, of Princeton, formerly of the Radiation Lab.) The networks may be extended throughout the world by putting relay stations in planes that spell one another in the stratosphere, (proposed by Westinghouse) or by bouncing the microwaves off the moon. (Planned by Federal Telephone and Radio Corp.)

Tiny radio receivers and transmitters, with circuits printed instead of wired (see p. 101), will be as common in pockets as fountain pens, with great savings in time, gasoline and shoe leather. In short, everyone may soon become accessible to everyone else, and that, too, is something for the thoughtful scientist to brood about.

PERHAPS the most ambitious goal of science is the duplication of the process of photosynthesis, by which plants, with the catalytic aid of their green chlorophyll, utilize the sun's energy in the production of sugar, starch, proteins, fats and cellulose.



lose—without which life on earth would end. If the efforts of many brilliant research men (like Dr. Eugene Rabinowitch, of MIT) should bear fruit, there might ensue a golden age of plenty for all mankind.

Many developments may be expected in the field of nutrition. Will a protein-deficient world eat cheap "beefsteaks" made from yeast? (Developed by Anheuser-Busch.) Will we feed our animals proteins made from wood scraps (pilot plant at University of New Hampshire), or on cheap synthetic urea made from coal? (Feeding tests at Wisconsin Agricultural Experiment Station.)



Will our descendants have everlasting teeth from drinking water containing fluorine?

Man may hope for the conquest of his cruelest diseases—cancer, rheumatic fever, arthritis and polio—if he really wants it. But not while he spends two billions for a weapon and passes the hat for health. Fund-raising drives may warm the heart, but they are no match for carcinoma, which is not sentimental.

THE huge industrial metropolis, a fairly new development in man's history, is one of his worst mistakes. The pattern of degradation is familiar: Real estate owners chop up dwelling units and create congestion, then those who can afford it move to the suburbs, leaving behind them run-down areas that yield low taxes. Then the city tries to stave off bankruptcy by floating bond issues, underpaying teachers and levying sales taxes. All the while, radial superhighway approaches are being built to jam the streets from curb to curb with transient vehicles. As a result, the place isn't fit to live in, and even its millionaires cannot buy the sunlight, clean air and recreation space that the village handyman gets for nothing. But cities can be excellent places for living, if we will heed scientific "visionaries" who are concerned with the needs of human beings.

If we select a number of ideas that have been proposed by advanced architects and planners, the city of the future may look like this: It will be surrounded by a multilevel belt highway near which industry will be relocated to isolate much heavy traffic. Within this great circle, the city is divided into self-contained sections, each circled by a one-way "ring street" to prevent through traffic and to restore to residential streets the character of additional "living space" that they had in the horse-and-buggy days. (Proposed for New York by architect Her-

mann Herrey.) Since it has been shown that the building of more and wider streets and more parking places simply lures more cars into town to fill the vacuum, all incoming private cars, with few exceptions, would park in lots provided at the city limits, where the occupants would receive free bus tickets to the center of the city. (Plan now being tested in Baltimore.)

METEOROLOGISTS would aid in city planning, breaking up streets to check cold winds. Walls of city gardens and courtyards and walls lining streets would have large louvers, like outdoor Venetian blinds, set to catch the sun's heat rays in summer and bounce them back into the sky. (Proposed by Dr. Albert E. Parr, Director, American Museum of Natural History.)

All heavily traveled sidewalks would have awnings or roofs to protect pedestrians from the elements (proposed by Edward Bellamy in *Looking Backward*), and snow would be melted on midtown streets by radiant heat from pipes imbedded in the pavement. (Now used on a road in Belmont, Mass.) Better still, snowstorms over cities may be prevented by sending planes to "seed" the clouds with dry-ice pellets, making them dump their cargo in the country. (Done experimentally by Vincent J. Schaefer, General Electric Co.)

These may not be the answers, but cities will adopt plans equally revolutionary, or slide further into their morass of fiscal and architectural bankruptcy.

WE MUST lessen the gap between the scientist and the rest of the world. The scientist is not a mysterious genius. He is an ordinary man with a highly developed respect for provable facts, who has learned accurate methods for sifting those facts from the chaff of conjecture, legend and wishful



half-beliefs. The man who masters a balky furnace and the woman who bakes a better muffin are often unconscious scientists.

People must come to a better understanding of laboratory men and their methods, for science plans our future and sends us the bills. When we don't know how to read them, we sometimes get stuck. And that's not all. History shows that it's dangerous for members of a small, powerful minority to consider themselves universally misunderstood. If we don't knock on their lucite towers and ask them to the clambake, a few ingrown fanatics may try to run the world on their own, and there will be a loud and final bang.

The responsible scientist of the future will be increasingly concerned with social problems. When people say that a certain human dilemma lies beyond the scope of science, it is often more accurate to say that scientific analysis has not yet been successfully applied to it. Race prejudice is one of the most challenging fields for tomorrow's scientists, and no one knows what physician, psychiatrist, anthropologist, ecologist or economist may discover facts that will help to end lynchings and ghettos. To what extent is race hatred a function of the income, occupation, nutritional status, dental condition and folk habits of the hater and the hated? Nobody knows. Science should explore the dark problem.

Juvenile delinquency, venereal disease and assorted neuroses present more jobs for enlightened scientists. It is not enough to treat these maladies after they occur. What would be the preventive effect of subsidized early marriages? Animals mate blamelessly when they reach biological maturity. *Homo sapiens* is expected to wait until he gets a raise or a house to live in. What ills derive from his abstinence, or from his guilt at violation of the social code? If a billion-dollar research project established facts leading to

a 10% improvement, it would be the greatest bargain of the ages. Also, manufacturers might sell more refrigerators.

The organization of our industry and agriculture has made us into a nation of movers. Trends in population movements should be anticipated, and practical methods should be adopted to ease the shocks of a family's readjustment to the new locale.



Today no enlightened corporation builds a big plant without considering the housing and transportation facilities available to its employees. What happens to the employee and his family when the plant shuts down or moves somewhere else is of equal importance to society.

Today, scores of eminent scientists, horrified at the killing power of the splitting atom, are earnestly working to unite all peoples in a master plan to harness it in the service of life. We'd better help them, and do it fast. Once we have jailed this blood-thirsty outlaw, the same plan can be used to control other scourges, both man-made and natural. Man will then have a chance to fulfill his destiny through science. Until then, we live by the skin of our teeth, awaiting the White Pillar of Doom.

END

HARLAND MANCHESTER, the author of "Science Never Stops," has written about scientific and technical developments for many leading magazines. As a roving editor of Reader's Digest, he spends much of his time in research centers and production plants throughout the United States, observing new machines and new methods and interviewing the scientists and technicians who use them. A native of New England and a veteran of the Marine Corps, Mr. Manchester is a former newspaperman and radio commentator. He is the author of *New World of Machines*.



***A message to
young men interested
in science, from
the President of
Harvard University***



Dr. James B. Conant, chemist and educator; chairman of National Defense Research Committee, 1941; president of the American Association for the Advancement of Science, 1946; member of the General Advisory Committee for the U.S. Atomic Energy Commission.

Educating a Scientist

By Dr. James B. Conant

IN APPLIED science, there is only one thing that can outmatch young men with good ideas, and that is still younger men with better ideas.

During the war, many scientists and engineers labored in what were to them new and untried fields. Indeed, I am inclined to think that a detailed analysis of the work of scientists in the National Defense Research Committee would reveal that some of the most important work was done by able scientists who came to a technical problem with no previous experience in the matter. Nuclear physicists working on radio fuses and radar; chemists and physicists dealing with subsurface warfare; physicists, chemists and engineers who had never heard of rockets before 1940 developing and manufacturing rockets in 1942—all these and many other cases demonstrate the point I have in mind. If the success of the hitherto uninitiated seems a paradox, it has its parallel in the history of more than one industry.

Well-trained men with capacity and imagination, when brought into a new field, often make startling advances. Why is this so? I think that the answer is to be found, not in

the great store of knowledge about specific things which these men have accumulated, but in their understanding of the strategy and tactics of science. Since our civilization is now so largely determined by advances in science, both scientists and nonscientists need to understand both the possibilities and the limitations of experimental and theoretical science.

Strategy and Tactics

The best way to get an understanding of science is to study important experiments that men have made in the past. You will find examples of such experiments in a little book, *On Understanding Science* (Yale University Press), based on some lectures I gave at Yale University last spring. One can see recurring certain basic principles of the strategy and tactics of science in the stories of such men as Galileo, Copernicus, Newton or in the less well-known accounts of men like Torricelli, Pascal and Boyle. I am inclined to prefer the latter. For the reader of the history of science should be warned against overemphasizing the role of the few brilliant generalizations that from time to time in the last 300 years have played so important a part in the advancement of

science. In my book I have tried to direct attention primarily to observation and experiment and the less spectacular and less known advances in the sciences.

In studying the history of science, a person will find certain points that have a wide application to science in general. Among these points are:

1. The influence of new techniques of experimentation and their connection with the practical arts. (Men could not study the behavior of materials in a vacuum until a convenient method of producing a vacuum had been invented.)

2. The evolution of new concepts from experiment. (Through experiment, men were able to discard the ancient idea that "nature abhors a vacuum" for the concept of an atmosphere of a weighable material air, the pressure of this atmosphere varying with the height above the bottom of the "sea of air.")

3. The difficulties of experiment, and the need for eternal vigilance in interpreting experiments. While the inherent "cussedness" of inanimate nature is something that only a man who has spent years in experimentation can fully understand, some appreciation of the pitfalls that surround the experimentalist can be acquired by the proper study of the history of science. (The study of the transmission of sound in air and in a vacuum is a good example of these difficulties.) In this connection, attention should be called to the importance of the controlled experiment. The essence of the controlled experiment is, of course, control of the relevant variables, such as temperature, pressure, light and presence of other materials. There is always a question of the necessary degree of control, and ways of estimating the effect of lack of control are of first importance. Progress in a given field often depends on recognizing what are in fact the relevant variables and devising methods of measuring and controlling them in the experiment. Errors frequently spring from overlooking important variable factors.

4. The development of science as an organized social activity. Science has always been related to the economic, political and cultural life of its times. In some cases, the channels in which scientific inquiry flowed were conditioned by political events and forces. The history of science has been influenced by such general events as the founding of the famous scientific societies in the 17th century. Any reader of science also should get at least a glimpse of the vast

literature of science that exists in the 20th century. The layman should know something of the methods of indexing and compiling this literature and gain some understanding of how, in spite of the volume of material, scientific news now travels faster than ever before.

So much for the understanding of science by nonscientists. Now let us consider what is necessary to make a well-rounded scientist in the present day.

Breadth of Vision

No man can properly serve the nation as a scientist today without a good grounding in what I call general education, which may be described as education for broadening a man's horizon. No man can be considered educated these days who does not have a share in the common core of man's knowledge, "the wisdom of the ages."

No one wishes to disparage the importance of being "well informed." But even a good grounding in mathematics and the physical and biological sciences, combined with an ability to read and write several foreign languages, does not provide a sufficient educational background for the scientists of a free nation. For such learning lacks contact with both man's emotional experience as an individual and his practical experience as a social being. It includes no history, no art, no literature, no philosophy. A person, *at every stage of his life*, must be concerned, in part at least, with the words "right" and "wrong" in both the ethical and the mathematical sense.

The good citizen of today will know something of the political and economic history of the past, and be able to relate this to the political and economic problems of the present. He will understand the evolution of science as part of the whole cultural history of the world. And he will read the literature and philosophy of the past as a help in meeting the problems of modern man and modern society.

Unless he feels the import of those general ideas and aspirations that have been a deep moving force in the lives of men, he runs the risk of partial blindness. In an age characterized by the terrifying potentialities of science and a highly contracted world, men cannot afford even partial blindness. **END**

Do You Know These "Young Men of Science?"

PSM's artist has portrayed them as they might look in modern dress. they were when they made their early contributions to science, and Check clues under pictures, then turn page upside down for answers.



1. He was a mere 26 when he published his report on relativity.



2. He was only 28 years old when he invented the cotton gin.



3. He was Director of the Harvard Observatory at the age of 36.



4. He was granted the first patent on his wireless when he was only 22.



5. He made first powered-plane flight when he was 32 years old.



6. He was only 38 when he proved that the steam-boat was practical.



7. He was 24 when he built the first multi-engined plane.



8. He was 24 years old when he discovered the law of gravity.



9. He invented the self-starter for automobiles when he was 34.

9. Charles Kettering
8. Isaac Newton
7. Igor Sikorsky

6. Robert Fulton
5. Orville Wright
4. Guglielmo Marconi

3. Harlow Shapley
2. Eli Whitney
1. Albert Einstein

Testers "Hug" New Cars



NEW railway cars are being given tests tough enough to make their hair—or their framing—curl. Pictured above in Budd's Railway Structural Test Laboratory, the new Vista-Dome is getting the works in a 2,000,000-pound horizontal testing machine, which can accommodate cars up to 95 feet in length. A huge ram gave the new observation car an 850,000-pound squeeze along the center line of the coupler. A wire

stretched alongside recorded the original length, and the difference after the squeeze told the deformation. The Vista-Dome took the squeeze with no permanent deformation; the windows didn't even break. The same results were obtained when 550,000 pounds were applied a foot higher on the center line of the buffer. These loads were 50,000 pounds greater than the requirements of the American Association of Railroads.



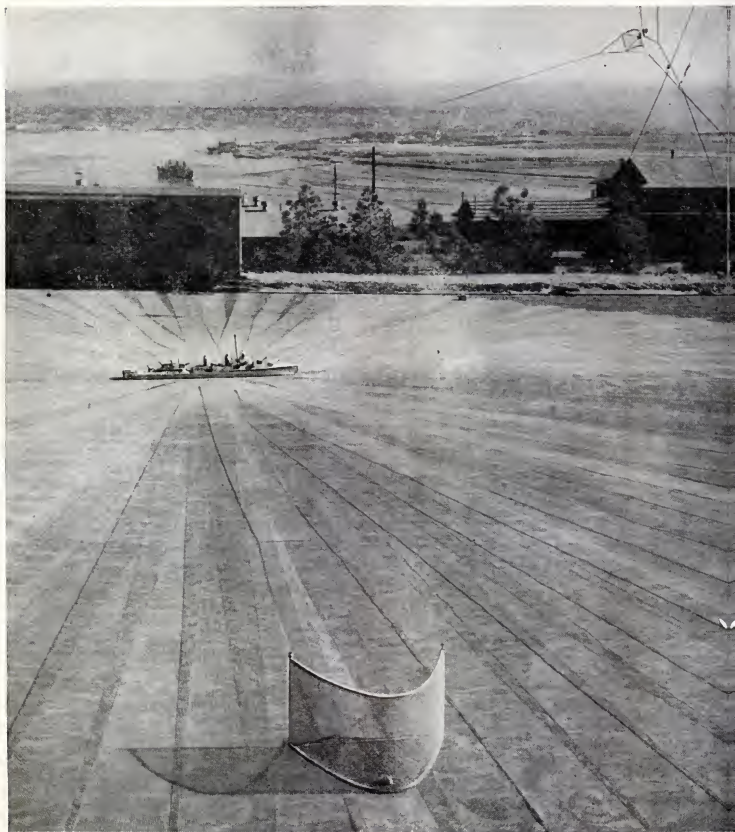
Taking readings of vertical deflection during the test of Budd's new Vista-Dome car. Gauge measures the car's contraction under a compressive load.



This huge ram, at left of picture, can supply up to 2,000,000 pounds pressure to test railroad cars. Jacks check body rigidity under torsion loading.

MAY
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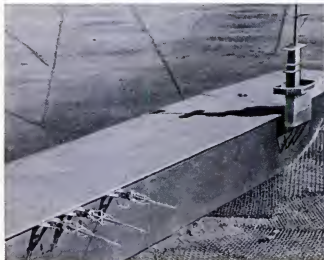
Chicken-wire Ocean Tests



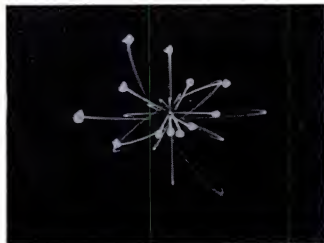
This destroyer model is being tested atop Pt. Loma, near San Diego, by the Navy Electronics Laboratory. The antenna in the air at right and the parabolic reflector at "sea level" in the foreground are used in conjunction with apparatus aboard the model. Both vertical and horizontal measurements can thus be made.

Navy's Eyes

MINIATURE ships of brass, sailing on seas of hardware cloth and chicken wire, are helping the Navy improve its communications. Both radar and radio are affected by the shape of a ship's superstructure and its relation to the antennas. Testing these effects on big ships involves swinging them through a tight circle while the signal strength of their transmissions is measured ashore. By building exact models and testing them with multiplied frequencies, distortions can be studied and better designs can be made far more easily.



The whip antennas (lower left) on this 1/24 scale model of a baby flat-top are being checked in the horizontal position they would be in when planes take off or land. Each transmits on a separate band, from 2 to 18 megacycles.



View of oscilloscope shows a sweep being made in several directions: The signals appear as blobs at the ends of the sweep lines. If the blobs were connected, they would form a pattern like that shown in the next picture.



This model of a carrier's "island" is twice the scale of the one on the left. Radio antennas and radar beacon are at the top, SK radar parabola at the center, and TDE communication antenna below. Model is built of 1/16-inch sheet brass.



This is the oscilloscope's report on a continuous, around-the-compass signal from a cruiser at 3.0 megacycles. The foremost suppresses forward and reflects rearward radiations. Investigation of such distortions is the object of the Navy's tests.

One-ton Howitzer Hits the Silk



The 2,240-lb. howitzer is loaded into the rear door of a C-82 Fairchild cargo plane. Packed on skids beforehand, it can be put aboard in 15 minutes.



A small ribbon 'chute, folded, was released as plane neared target area. Now, at the drop point, it has been tripped and fills, left, to pull out cargo.

MILES up, a ton of howitzer slides out of a plane into space—and floats gently to the ground. That's the latest trick AAF engineers have pulled with their improved version of the German ribbon parachute.

The 75-mm. howitzer is carried on wooden skids and loaded on a ball-bearing wheel conveyer located on the floor of the plane. A 14-foot ribbon parachute drags it out of the plane, and as the cargo falls it pulls open the big 90-foot canopy 'chute that eases it to the ground.

The ribbon parachute eliminates both the usual opening shock and the tumbling of the cargo as it hits the slipstream. Because the cargo's forward motion is reduced, it is more likely to land where aimed.

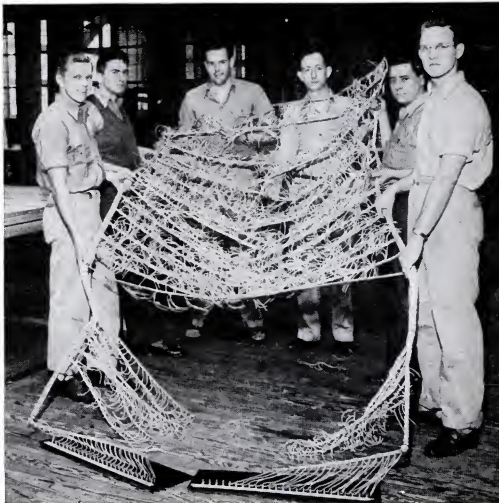
The ribbon parachutes are also proving their worth in dropping instruments out of V-2 rockets 70 miles up in space. Now the 'chutes are even bringing the whole rocket back to earth after its upward impulse has been exhausted, permitting it to be re-used.

Once out, the cargo is floated down by a large 90-foot canopy parachute. The extraction 'chute stays open alongside to stabilize against swings.



Inside the Biggest Man-made Brain

*Navy's new calculator
has steel bones,
silver nerves,
paper impulses, and
can make mistakes.*



This intricate, bedspringlike maze of wiring shows the complexity of the giant "brain." All panel wiring was done first on jigs, laced for identification.

By Stephen L. Freeland

THE LARGEST brain in the world today is a mammoth electrical mathematician being built at Harvard's Computation Laboratory for the U. S. Navy Proving Grounds at Dahlgren, Va. But its reign as king of the robots will be brief.

Work already has begun on faster, better calculators based on the lessons learned in creating this machine, known as the Dahlgren Calculator, or Mark II, just as this one was designed to be the big, tough brother of Mark I, which was built for Harvard during the war by the International Business Machines Corp. (PSM, Oct. '44, p. 86).

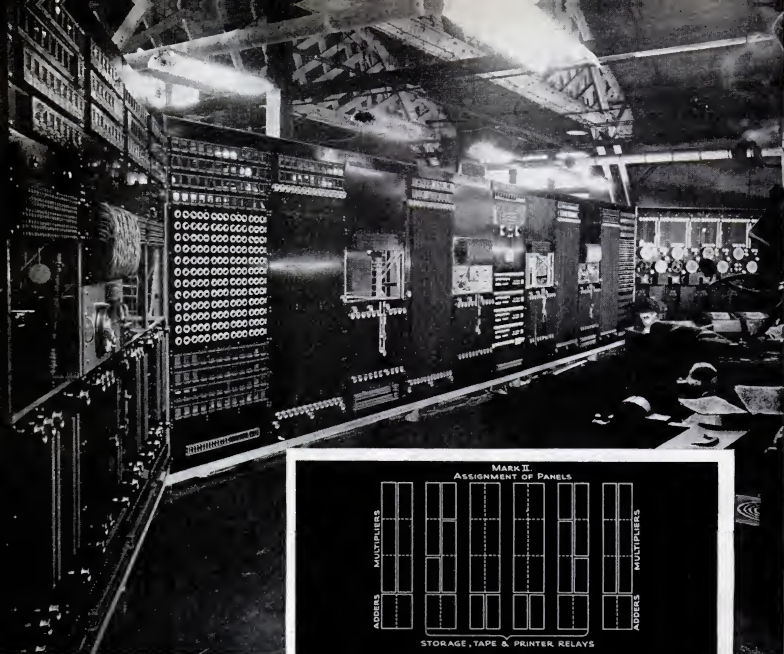
Mark II, however, will not be retired. Even Mark I has many years of useful labor ahead. There is plenty of work waiting for all the big calculators now in existence and on the drawing boards. Mark I is still churning out answers to abstruse mathematical problems 24 hours a day, and Mark II will be taken to Virginia next month to begin an equally strenuous career.

Mark II is simply larger, faster, more

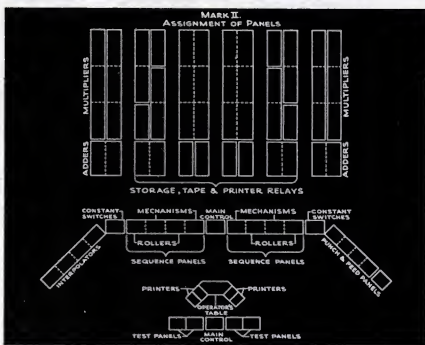
versatile and more flexible than Mark I. The difference between the two machines, however, starts right at the eight-foot-high front panel, which is 60 feet long and shaped like a shallow "U" in Mark II, 51 feet long and straight in Mark I. Adders, multipliers, interpolators and instruction mechanisms are all let into this front panel like drawers in a bureau in Mark II. Two men can handle them easily, and if one unit goes haywire, it can be removed and a spare one slid into place with no waste of time. In Mark I no such substitution is possible.

Answers Roll Out on Ribbons

There are other differences, too. Long strips of paper tape run on aluminum spools across four panels of Mark II, and one entire section is devoted to printing and storing these tapes. Punched in code, they pass through delicate fingering devices on the panel; depending on how they are punched and where they go, they tell the calculator what numbers to use and how



The long main panel board of the Mark II Calculator, shaped like a shallow "U," is shown in the angled view above. The diagram at right is a floor plan of the computing machine showing the arrangement of the main board, the control desk in front of the board, and the six relay cubicles behind it.



to use them. Mark I also uses tapes, along with punch cards, but the tape is broad and heavy and forms a complicated and bulky maze behind the panel, where it is hard to get at. On Mark II a tape can be changed in a minute.

Mark II is hooked up to a battery of four teletypewriters, with a fifth as a standby, while Mark I has only two. Mark I displays a 30-foot stretch of glass window behind which the spinning gears of the counters may be observed, whereas Mark II has no visible moving parts except for the spools of tape.

Unlike as the two machines are in appearance, it is not until one goes behind the panels that their real difference is seen. While Mark I performs its functions almost noiselessly by a combination of mechanical gears and electrical relays, Mark II's calculations are all done in a whirling clatter of relays. There are 13,000 of them in place now, and positions are available for 2,000 more if needed.

Actually, Mark II uses three kinds of relays: a single coil, a double coil, and a double coil with a latch. All were designed and developed by the staff of the Harvard



Visible over the top of the main board, above, are several of the six big relay cubicles where all of the actual calculations are performed. At the low control desk shown at left, one man can operate the entire machine. Facing the main board, he is surrounded by five teletype machines, four for normal operation and a spare for emergency use. At his back is the operating control board.



Computation Laboratory in co-operation with the Autocall Company, of Shelby, Ohio. Their contacts are made of a special silver alloy that enables them to operate at least 100,000,000 times at a pulse rate of five milliseconds.

Each type of relay has a different job to perform. The single coil simply acts as an immediate transfer agent for a number, shooting it right into a computation; the double-coil relay can take a number and hold it for a certain predetermined number of pulses—carry the number in its head, in effect; the third type, the double coil with

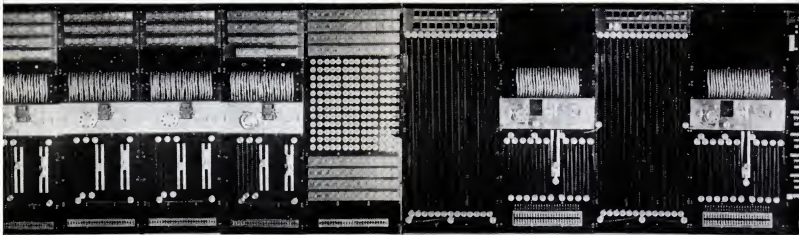
latch, will hold a number indefinitely until it receives a special signal to put it into the calculation.

Mark II can perform in less than one second multiplication that takes Mark I nearly six seconds. And since Mark II has four multiplier units, compared to only one in Mark I, it can do four such operations at the same time. All the other jobs are speeded up in like degree, and frequently the Mark II will get answers faster than the one-per-second rate at which the printer can record them.

Faster Recorders Are Needed

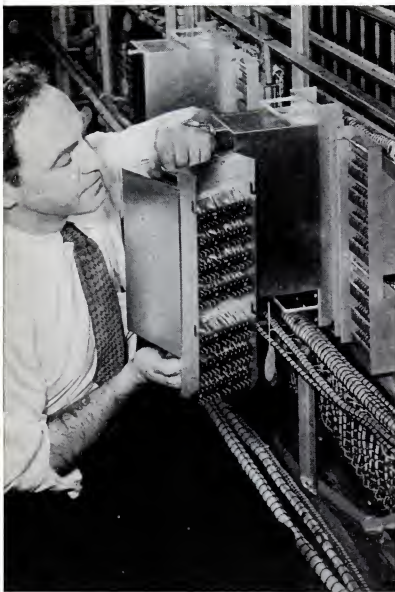
The business of speeding up recording, incidentally, is bothering the builders of big calculators right now. The Army's ENIAC (Electronic Numerical Integrator and Computer) and EDVAC (Electronic Discrete Variable Computer) are perhaps 1,000 times faster in getting answers than Mark II (PSM, Apr. '46, p. 83). They hit the same bottleneck of printer speed, however, when it comes to writing them down.

The not-yet-completed EDVAC, for example, uses a series of mercury tanks capable of "memorizing" up to 1,000 10-digit numbers and referring to any of them in an average time of 1/5,000 second. Also, its system of magnetic tapes, upon which problems are coded and their results obtained, is similar in purpose but superior in speed of operation to that of Mark II's perforated paper tapes. Its actual over-all speed, however, is still dependent upon the rate at



The eight-foot-high, 60-foot-long main panel board is shown above as it would appear if laid out flat. Indicative of its simplicity are the plug-and-jack connections that make all wiring installations possible in a matter of seconds. Sliding spools, famili-

arly known as "yo-yos," permit variations in the length of the paper tapes and their almost instant removal. A system of lights across the top of the sub-main control panel (center panel) reveals intermediate calculations prior to the final answer.



Accessibility is an important achievement in the construction of Mark II. The ease with which the entire mechanism of this rotating stepping switch can be removed is characteristic of its design.

which its conclusions can be written down.

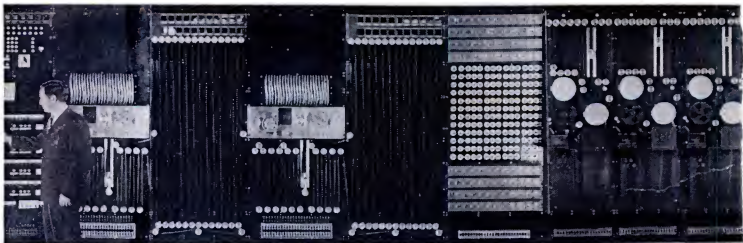
A possible solution to the problem of printer speed has been suggested by the development at Harvard of the "numeroscope," a cathode tube that would flash an actual number when energized. A battery of these tubes would, of course, permit the calculator to write any number it wanted as quickly as it got the number. At present, however, there is no film fast enough and of sufficiently fine grain to get clear photographs of numbers flashing so swiftly.

Simplicity Speeds Assembly

Mere speed, even when its full use is made possible, is only one of the advantages obtained by using relays in Mark II. Equally important is their greater accessibility for maintenance and repair. Ranged in banks along the exteriors of six 15-foot-long cubicles, the relays are easy to get at.

They are, moreover, interchangeable with others of the same type; to make replacement completely foolproof, each type of relay has its own color on its case and on the blank into which it should go. A man would have to be color-blind to try to jam a black double-coil latch relay, for instance, into the place belonging to a red single-coil relay.

The wiring of Mark II is also a masterpiece of accessibility and mobility. Every panel can be moved without touching any but external wires. These external wires, like the wires on the panel itself, are clearly identified. Panel wiring was completely laid out, laced on jigs and brought to the panel itself as a unit before a single connection was made.



The sub-main control panel, operated by the technician above, co-ordinates the two separate but substantially identical sections of the board. Each section consists of five panels similarly arranged on either side of the sub-main control panel—two

for sequence mechanisms, two for tape storage, and one of mathematical constants. In addition, each section is connected to two of the four tape punch and feed panels at the extreme right and two of the four interpolator panels at the extreme left.

When Mark II goes from the computing lab in Cambridge, Mass., to the Proving Grounds at Dahlgren sometime in June, only 15,000 out of some 300,000 connections for over 1,000,000 feet of wire will have to be broken and remade. The bolted angle-iron construction of the machine's framework makes it simple to take apart and move.

Convoy Will Move It

Moving will be done by a 25-trailer-truck convoy, with one whole truckload devoted to testing equipment. Once the machine gets to Dahlgren, it will take two to three months to set it up and test it. The boss on the job will be a graduate engineer from Cornell, Mr. Frederick G. Miller, who has worked on Mark II from the blueprint stage.

Mr. Miller, with a staff of five mathematicians and a crew of 12 maintenance and repair men, all trained under the supervision of Dr. Howard H. Aiken, head of the Computation Laboratory at Harvard and a leading authority on large-scale calculators, will stay with Mark II as civilian employees of the Navy. They will keep the machine running 24 hours a day, every day in the year.

Testing a big calculator is like training a mule—the man has to know more than the mule. There will be the arduous matter of checking all contacts, then every circuit, then groups of circuits (there is a special machine for this, built at Harvard, which acts like a baby calculator itself) and then of making trial runs of problems.

Because Mark II is built in two halves, like the two lobes of the human brain, it will be possible to check one half against the

other. Finally, the entire machine will be given a problem for which the answers are known—perhaps something Mark I has done already. If it pulls through that, Mark II will be ready to roll for the Navy.

Even after it gets into operation, however, Mark II can make mistakes, and one of the biggest jobs Mr. Miller and his team will have will be guarding against them. The machine itself will help in this. It has 30 "check circuits" built into it, and the mathematician who sets up a problem punches instructions into the tape that brings these checks into operation.

If a result fails to pass the check circuit, bells ring, lights flash, and the whole computer stops like a tilted pinball machine. Then the trouble-shooters go to work, tracking down the source of error by the same process of progressive isolation a radio repairman uses in fixing a balky set.

Six Twelves vs. Twelve Sixes

A simple example of how a check circuit is used is in multiplication. Whether done with paper or pencil or by relays, multiplication is, after all, only a way of adding. Six times 12, for instance, is 72, whether one gets the answer by grade-school methods or by adding a column of 12 sixes. Mark II, like most calculators, does it the hard way, taking 12 separate sixes out of 12 separate relays and adding them.

To check that, the machine is also asked to take six twelves out of their relays and add them. Then both results are passed through the check circuit: if they agree, fine; if not, the machine stops. In much the

same way, checks are put in for using trigonometric functions to establish mathematical identities. These check circuits were developed by the Computation Laboratory and are found both on Mark I and II, but not on any other existing machines.

Sometimes these check answers are not absolutely the same, but they can still get past the check circuit at the mathematician's discretion. The difference comes about because Mark II is correct only to 10 significant figures (Mark I works out to 23 figures and can be rigged to go to 46), and in "rounding off" two series of numbers from a problem done two different ways a discrepancy may pop up in the last figure.

There is a special "tolerance" control in the check circuit to take care of this. The mathematician may decide that a difference of one in the 10th significant figure is okay for his purposes, so he sets that in the circuit, and if the two answers differ by one or less, they go right on; if they differ by more, the machine stops.

Obviously, much depends on the mathematician. He has to know what the machine can do and just how it does it. That is why those in the laboratory, who even now are engaged in building Mark III and planning Mark IV, look forward to the day when they will turn away from constructing machines and get to work on the even more important task of training mathematicians and engineers to handle them.

Large-scale computers like Mark II are

not put to work to find *one* answer to *one* equation, any more than a pressure cooker is used to boil *one* three-minute egg. They are used, instead, to get a long series of answers to the same equation where the variable factors change a little bit each time. A gradual change in a variable should produce a gradual change in answers, which, if charted, would show up as a nice smooth curve.

A mathematician can sense this curve without charting it, just as an old fisherman can tell when his boat is drifting without taking bearings. Any sudden departure from the smooth curve shows that the calculator is making mistakes. Occasionally, though, there are some surprises.

Some of the people at Harvard got a surprise during the war. One day they received from Washington a formula to run on Mark I, with no further information than orders to do the job right away. They put it in the machine, and for a while the answers built up slowly in a nice, normal curve. All of a sudden they went completely haywire; the curve stopped being a curve and became a mountain peak. Then the peak itself got higher and higher.

The watchers tested the machine up and down, but it looked all right. They thought that the machine had gone crazy but couldn't prove it.

Months later an atomic bomb burst on Hiroshima. That made the astounding answer to the problem plausible. END

Televising Surgery

CLOSE on the heels of prophecy, the first television broadcast of an actual operation was made late in February as a test to determine its practicability for surgical education (PSM, Feb. '47, p. 66).

Presented by Johns Hopkins in co-operation with RCA, the experiment enabled 300 doctors to witness the so-called "blue" baby operation (delicate heart surgery to correct an oxygen deficiency).

Two transmitters, one directly above the operating table and the other in the gallery with a telephoto lens, provided a view of the operation as clear and inclusive as that of the surgeon himself. A microphone above the table permitted the surgeon to comment during the operation.



PSM's February conception of televised surgery (above) envisioned the use of auditoriums. The Johns Hopkins test promises such a development.

Transmitters Shrink to Lipstick Size



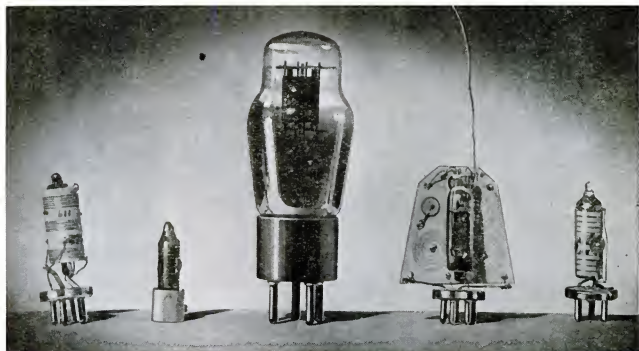
THE guy who tells you that you'll soon be talking through your hat may not be talking through his. For now your hat is plenty big enough to hold a complete broadcasting station. The printed, or painted, radio circuits developed for the proximity fuse, already used for receivers (PSM, May '46, p. 131), have been applied to transmitters.

These laboratory models, no bigger than a lipstick, are the after-hours work of Dr. Clelio Brunetti and fellow experts at the National Bureau of Standards. Tiny transmitting circuits are painted on the outside of subminiature tubes. Only microphone and batteries are needed to complete the units.

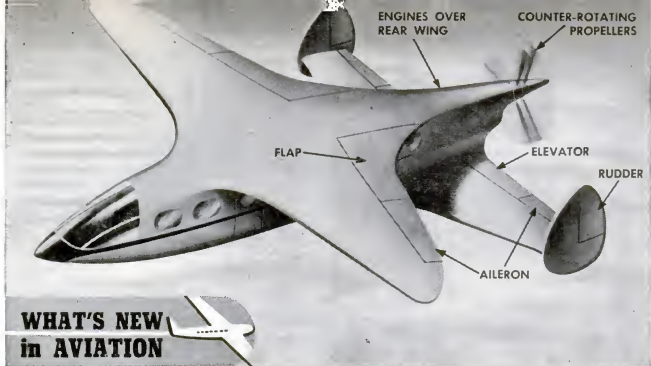
Combination of the new transmitters with the printed-circuit receivers opens the door to personal, two-way communicators. Special FCC permission was obtained to test the transmitters on the two-meter ham band, but

the miniature "transceivers" will probably be most used in the 460- to 470-megacycle Citizens' Radiocommunications Service that the FCC has set aside for unlicensed civilians. Broadcast range under ideal conditions might be 40 to 50 miles, but surveys show that demand is centered on very short-range communications. For this, both battery and antenna can be kept small enough for easy portability.

Wide interest has been aroused by the miniatures. A chain store would like to use them for taking inventories—the lister would just name each item on the shelf and a checker in the office would hear and record it. Police propose to link their individual patrolmen to headquarters. Farmers hope to talk across the fields. Waiters can whisper orders into the kitchen. And mothers see a fine way to keep tabs on what little Johnny is up to when playing outdoors.



Four models of painted-circuit transmitters are lined up beside an ordinary radio tube to show comparative size. Type mounted in lipstick holder in top picture is only $\frac{1}{4}$ inch in diameter and one inch long.

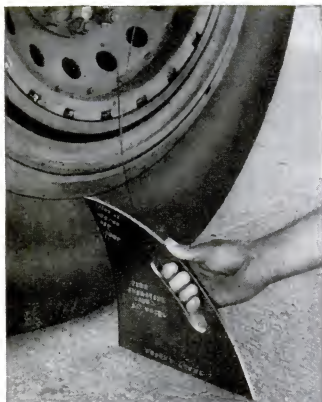


WHAT'S NEW in AVIATION

Germans Wanted It

THIS odd plane cost its designer three years in a Nazi prison. With a 300-m.p.h. top speed, it can mush down to a nose-up landing at 47 m.p.h. The Germans wanted details for a new attack plane—and Frenchman Maurice Delanne refused. Now he plans

a U. S.-built, 10-passenger transport (above). The low wing replacing the tail gives so much extra surface that the plane, instead of stalling, is said to drift down at 12 feet per second. The 35-percent extra lift also permits the load center to be far from the center of gravity, so the two 500-hp. engines are tail-mounted without a long shaft.



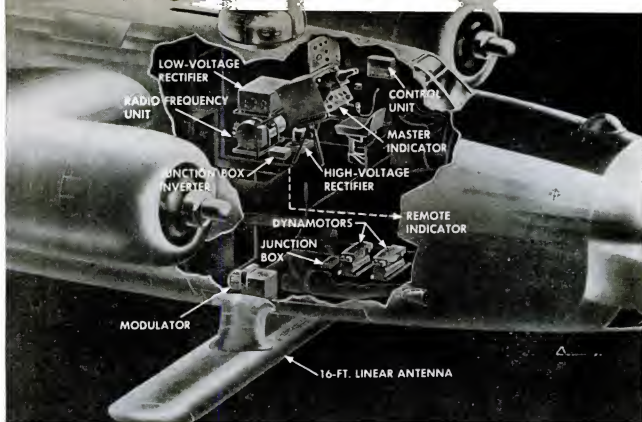
Tests Tires Visually

PLANE tire pressures can be tested by eye alone with this simple Consolidated Vultee gadget. The measure is set on the ground beside the tire: if the upper point just touches the rim, the pressure is okay.



Three-in-One Suit

THIS AAF cotton-twill suit combines a life jacket that floats its wearer face up, a light flying suit, and an emergency sustenance vest. It cuts the weight of flying clothes by about two pounds.



Eagle-eyed Radar

THIS 16-foot Eagle radar antenna structure, a wartime secret, is really 250 individual antennas. They replace the usual rotary disk

or spinner to provide greater resolution and thus more scope detail. The Eagle meant more accurate B-29 bombing at night or through overcast. Now it is being used for GCA and MEW air-traffic control systems.



One-stop Service Station

TIRED of running out on the line to diagnose electrical troubles on aircraft and then running back for tools and equipment, two AAF civilian employees have designed and built a portable shop. Used at the Clinton

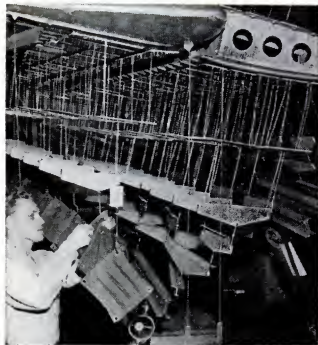
County Army Air Field, Wilmington, Ohio, it can be taken to any plane needing electrical service, checking, maintenance or installation. It is estimated that 50 percent more work can be done with the unit, which is contained in a three-wheel cart and weighs less than 600 pounds.



Trainer Is Missing Link

A NEW North American trainer, the XSN2J-1, fills a gap in the Navy's training program. Fast enough to give the feel of tricky, high-speed fighters, it is simple

enough for intermediate students to fly. The all-metal, two-place trainer is unusual in putting the student in the forward seat to get the feeling of flying alone. A Wright nine-cylinder engine gives a 270-m.p.h. top speed. Service ceiling is 30,000 feet.



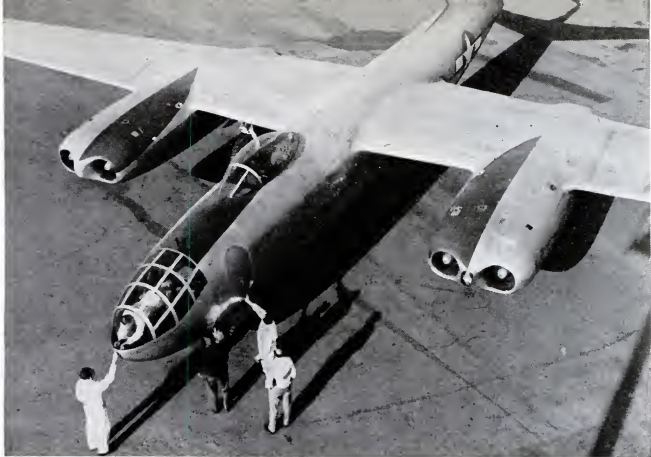
Spokes Test Planes

THIS maze of bicycle spokes can exert all the stresses that a plane meets in flight. Each links the skin of the aircraft to a hydraulic jack. Here engineers use it to test Northrop's new transport, the Pioneer. Shot bags in foreground apply minor loads.



Camera Scorns Shutter

THIS AAF camera, the S-7, has no shutter—and doesn't need one. It is used by fast planes for treetop photography. Motor keeps film moving past lens as fast as objects on ground move on camera's focal plane, so image is motionless on film.



The XB-45 boasts a slender, fighterlike fuselage, but it can carry more bombs than the wartime "heavies."

AAF Tests First Four-Jet Bomber

NORTH American's XB-45, undergoing tests at Muroc Army Air Base, Calif., is the first four-jet bomber to fly in the U. S. Its engines—General Electric J-35s set in pairs in two nacelles—are said to give it an "exceedingly high" speed. Gun turrets have been eliminated for streamlining, and the

only protuberance is the "bubble" in which pilot and co-pilot sit in tandem. Although the XB-45 compares in size and range with the heavy bombers of World War II, it is classed as a medium. It has a wing span of 89½ feet, is 74 feet long, and accommodates a crew of four men.



Streamlined bombardier's nose is reinforced to withstand stress of high-speed flight. The plane has a refrigeration system to offset frictional heat.



Twin-jet nacelles are ahead of wing's leading edge for easy accessibility. The new high-pressure tire was specially developed to fit into the thin wing.

300 Volts in the Palm of Your Hand

TWO hundred 1½-volt cells have been crammed into a one-pound package by engineers of the National Carbon Company to produce a small fistful of high voltage. At approximately 300 volts a pound, these Eveready batteries can deliver several thousand volts without adding greatly to the size or weight of portable equipment.

One immediate application for the new batteries is in completely self-contained Geiger counters used to detect the presence of radioactive substances. Portable Geiger counters are finding increasing use in such fields as medicine, metallurgy and geology—not to mention nuclear physics. One of the smallest radioactive detectors produced up to the present, only 11 inches long, is pictured at the upper right. Three batteries in series provide the 900 trigger volts needed to make the counter tube and amplifier tick off the presence of particles from radioactive elements.

Repeating photoflash tubes of the gas-discharge type also need high voltages but little current. Six or seven series-connected batteries have enough electrical energy for 2,500 flashes—plenty to keep a news photographer clicking for many months.



This Geiger counter, made by Instrument Development Laboratories, Chicago, weighs only 10 lb. complete with case, probe and batteries.

Compact battery construction has largely been made possible by new techniques for sealing in sandwich form the carbon-electrolyte-zinc cell invented nearly 60 years ago. Plasticized sealing materials have reduced the nonproductive space by eliminating the metal cans and other bulky liners that were formerly needed to prevent the semifluid electrolytes from intermixing and short-circuiting. Flat squares, moreover, may be stacked with much more economy of space than the rounded or cylindrical cells. Ten wax-impregnated stacks, each containing 20 individual cells, make up this latest addition to industry's stockpile of portable power.



Close-up shows compactness of 300-volt battery made of 10 stacks of flat cells. It is slightly less than three inches square, just under four inches high.

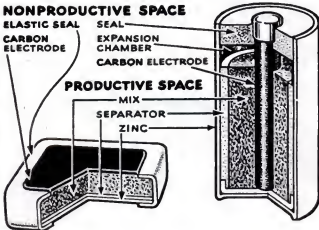
POPULAR
106 SCIENCE

NONPRODUCTIVE SPACE

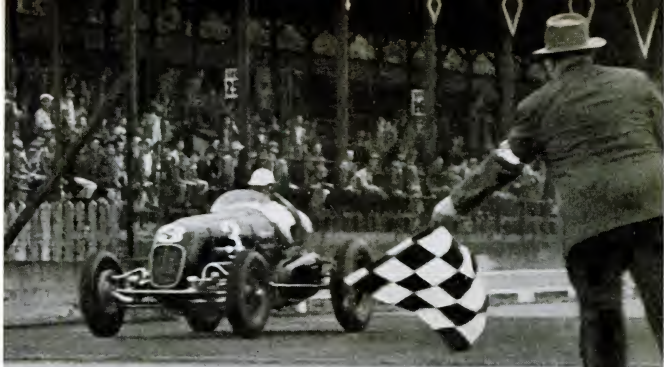
ELASTIC SEAL
CARBON ELECTRODE
SEAL
EXPANSION CHAMBER
CARBON ELECTRODE

PRODUCTIVE SPACE

MIX
SEPARATOR
ZINC



Cutaway diagram shows how flat cell construction cuts nonproductive space by eliminating thick seal, heavy carbon electrode and expansion chamber.



Mechanics Win the Races

Speedway drivers and cars alike depend on skill of men in the pits.

By Devon Francis

WHEN the winner of the annual Indianapolis Speedway 500-mile race streaks across the finish line late this month to the thunder of applause, a man in the pits, ignored by the crowd, will relax his grip on a grimy stop watch, grin to himself and start collecting his tools.

His name won't be in the headlines. When the cameras click, he will be only a face in a sea of faces. But to those who know automobile racing he will be the hero of the day. For he will be the winning car's chief mechanic.

It's largely the mechanics who win the races. They are the nursemaids of the delicate and temperamental machines that for hours on end pound around the world's greatest closed raceway for wheeled vehicles. They are far more than that, though. They are practical engineers, surgeons on call for emergencies, father confessors to racing drivers, coaches who call their signals from the bench.

A good mechanic is a Jimmy Valentine in overalls. By feel, by ear, he can perform a

diagnosis on his racer in a matter of seconds. Last year Ted Horn, at the wheel of an Italian-made Maserati Grand Prix car, coasted into his pit on the seventh lap with a dead engine.

"What happened?" asked Harry W. ("Cotton") Henning, dean of all the Indianapolis race mechanics, even before the wheels had stopped rolling.

"It began to pop," said Horn. "Then it quit."

Henning's practiced fingers already had the hood up.

"Did it get rough?" he called from the bowels of the racer.

"Yes."

Seven-minute Surgery

Henning ripped out the magneto. In six minutes and 45 seconds he had replaced it with another. He recognized the engine roughness as a timing ailment in the ignition system. The magneto rotor had, in fact, sheared. The Maserati, tailing the field, rolled back on the track and went on to take third place.

Mechanics have to be fast. Seconds count. Riley Brett, of Los Angeles, once changed a wheel for Wilbur Shaw in 7 2/10 seconds, probably a world's record. Shaw, president and general manager of the Indianapolis

Motor Speedway Corp., retired from racing now, is a former mechanic, by the way.

The mechanics are a breed by themselves, living with their noses on their engine blocks. Some of them follow the seasonal sun to automobile races all over the United States. The consuming ambition of each of them is to have a winner of the Indianapolis 500.

Planning Starts from Scratch

Planning for this race, richest in prize money in the United States, starts practically on May 31, the day after the current year's race is over. The mechanics tinker, tear down, rebuild. They examine every part of their cars. The machines have to clock as high as 170 miles an hour on the straightaways to get a net of 115 or so, and a defect can lose a race or cost a life.

In the springtime the work accelerates. All last month the mechanics who hope to place their cars among the 33 qualified starters on Memorial Day were having the drivers feel out the machines. The feel is important. Like any roadway, the track is full of imperfections. As Shaw puts it, "No matter how fast you go, it's the longest 500 miles in the world." A car must cruise as smoothly as possible so a man will take no more of a beating than he has to; the seat must be adjusted to a perfect fit.

Diagnosis by Touch

After each test run, a car goes back into the shop. Here the mechanic turns the engine over by hand, slowly, waiting for his ears and fingertips to tell him if anything is wrong. Almost any good mechanic can make a car go fast. The problem is to make it go fast for 500 miles. That's about equal to the highway distance between Denver and Salt Lake City.

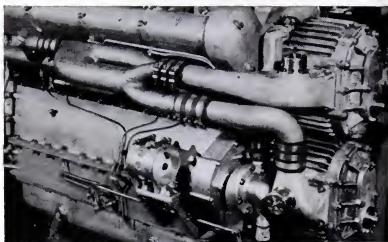
As one step toward long-distance speed, the master mechanic experiments with the fuel mixture. And don't ever ask a racing car mechanic what his fuel mixture is. Some cars use an alcohol blend, some a gasoline blend. The blends are top secret with the individual mechanics and are varied to fit the temperature and humidity of the day.

Since racing engines turn at twice the rate ever asked of a stock-car engine, mechanics deliberately allow for five times the clearance between piston and cylinder wall that is manufactured into a stock engine—as much as 15/1,000 inch. That's to reduce friction and keep down heat.

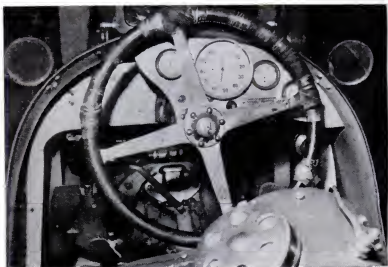
Entries in the 500 customarily are torn



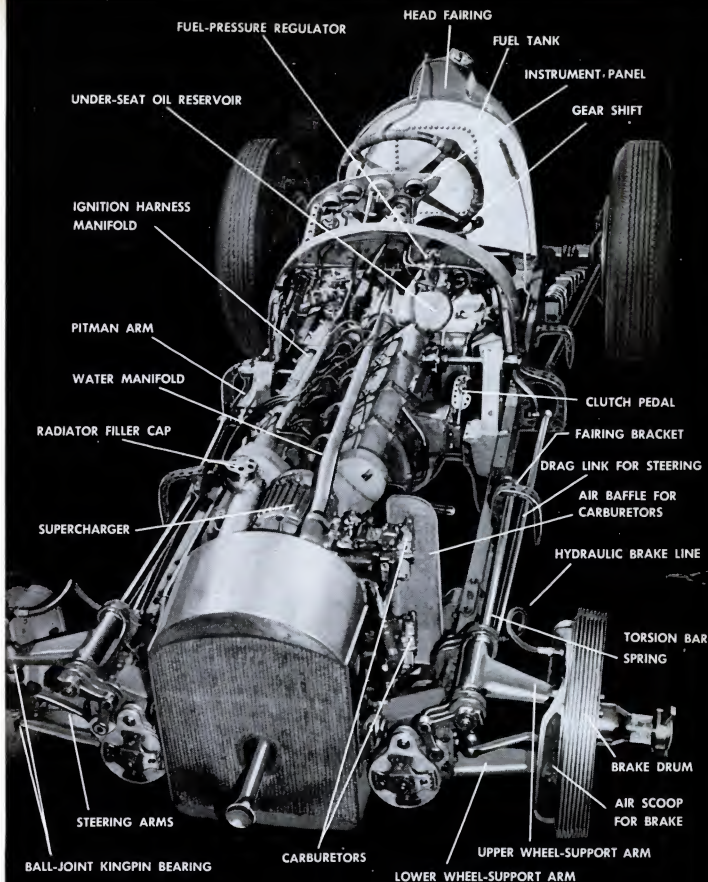
Cotton Henning, master mechanic, has played nurse to four Speedway winners: 1925, 1934, 1939 and 1940. This year he is an owner as well.



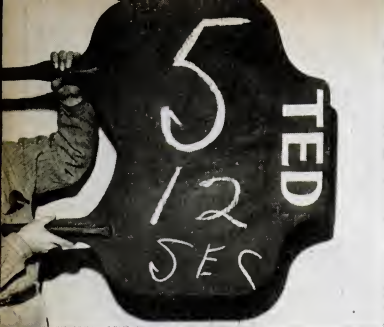
Two Roates-type blowers (extreme right), fed from two carburetors, turn at engine speed to produce 14 pounds of manifold pressure on Henning's Maserati. Piston displacement is 179.2 cubic inches. Some mechanics prefer centrifugal blowers, which supply greater pressure but have to turn faster.



Dials on Maserati (l. to r.) tell water temperature, engine speed, oil pressure and air pressure on fuel. Cap of 52-gallon fuel tank is in foreground. Wheel is gouged and knob-taped to give driver a firm grip.



The Maserati has a "dry weight" of 1,920 pounds, but weighs 600 pounds more, including its driver, on the starting line. Its wheel base is 108 inches; tread, 55 inches. Most racers have three speeds forward, but the Maserati has four



The figures on a pit blackboard tell driver "Ted" that car No. 5 is only 12 seconds ahead of him, and position of the board tells him to overtake it. Such codes must be simple, but in the pinches competing drivers should not be able to read the message.



Herringbone grooving on piston walls (shown on the left) is a new wrinkle on engines for the 1947 race. It is designed to retain oil longer than does the smooth-walled piston on the right.



New Firestone tires with half-tread will be tried this year to even tire wear when rubber is scrooped off on turns. The track is abrasive to begin with, but gets coated with so much rubber in the first 100 miles that tire wear decreases thereafter.

down for final inspection a few days before the race. Occasionally the reassembling isn't completed until the last frantic hours before the cars start the pacing lap.

On race day, with a single car's mathematically possible winnings upward of \$40,000, the master mechanic and his crew of three or four men have completed only the preliminaries of their job. Now the real work starts.

Tips to the Tyros

Master mechanics have given the inexperienced eager beavers among the drivers their final instructions:

"Don't get into traffic"—don't get into a swarm of cars. Only the older hands can take such chances.

"Don't get in over your head"—don't get beyond a speed that you can control.

"Watch your pit. We'll tell you if there's a chance to pick up the car ahead"—if there's a chance to overtake him.

"Feather it on the turns"—ease off speed leaving the straightaway and take the turns with just enough throttle to get maximum performance on each lap.

"Don't stand on it unless you're clear"—don't open up unless you have room to pass.

"Above all, don't lose it"—don't lose control of the car, particularly on the turns.

Driver and master mechanic have set up a code for chalking messages on a hand-held blackboard that can be read as the car flashes by. Stop watches are calibrated. The pit must keep tabs on the relative positions of 10 or 12 cars in the elapsed-time vicinity of its own car.

The race is run from the pits. Once a driver has made a few laps and the cars are strung out around the saucer, he hasn't the foggiest notion what his relative position is. He has to depend on his chief mechanic for information. He is also beholden to his crew for fuel, water and repairs—but not for oil. He can't take on oil, once the race is under way. That rule was made to keep the track from getting sodden with oil from leaky engines.

Lost Seconds Lose Races

Governing the speed of its car is a split-second business for the pit. It is done on a basis of seconds gained or lost on laps. A gain or loss of one second on a lap can spell the difference between prize money and a total loss for a year's work. The pit must keep an eye on the lap prizes, too. Money

for the best speed for single laps aggregates \$20,000 or more.

Typical of smart pit work was that in 1934 when Wild Bill Cummings was 30 seconds behind Mauri Rose, with only 50 of the 200 laps to go. Thirty seconds is a long time in an automobile race.

At lap 160—25 miles later—Cummings, coached from his pit, had gained three seconds. At lap 170 he had gained 14 more to increase his rate of gain by 1 1/10 second a lap. In the next five laps he boosted his gain to 2 6/10 seconds a lap. At that point he picked up Rose, and his margin of victory was 27 seconds at an average speed of 104.865 m. p. h.

Shaw, who is the only man besides Lou Meyer to win the race three times, almost lost second place in 1938 after he had it in the bag because of that lap-seconds-gain bugaboo. The pit crew of Chet Miller, cruising behind him, sensed that Shaw's pit had gone to sleep and signaled its man for a speedup. Shaw, pounding along at a respectable 115-m. p. h. average, had no inkling of trouble until Miller had picked him up. It was too close to the finish for Shaw to make up the time. Then, suddenly, Miller had to refuel. Shaw, grinning, saluted both crews as he roared by.

Henning Was Right

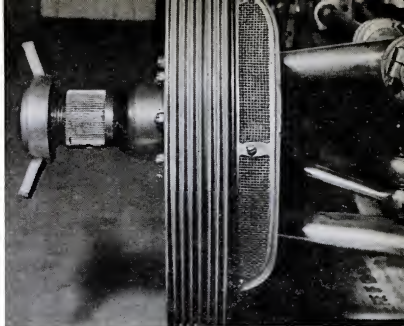
Shaw almost got into trouble the following year because he didn't heed Cotton Henning's admonitions. He made his first scheduled refueling stop at lap 69. His next and last, Henning said, was to be at lap 140. On lap 107 a three-car smashup occurred and the yellow caution flag went up. When the racers are circling under a yellow flag because of wreckage, they must reduce speed and maintain their relative positions. Shaw thought this was a golden opportunity to refuel. He rolled to his pit on lap 127.

Henning shook his head. "You'll never make it," he protested as the fuel, propelled through its hose by compressed air, gushed into the tank. "You'll run dry."

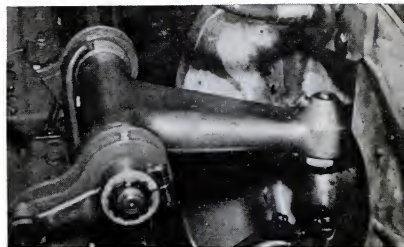
"I'll make it," replied Shaw confidently.

On lap 191 his engine sputtered. He saw \$20,000 in first-prize money dribbling through his fingers. But Henning, the fox, had installed a one-gallon auxiliary fuel tank before the race for just such a contingency. With it Shaw managed to make his pit.

Ordinarily the refueling stop would have taken 30 seconds. With the carburetors dry, it took a minute and a quarter to get Shaw



Rapid-fire tire changing is made possible by the single wing nut and the hub serrations onto which the wheel slips. Screened scoop at right of finned brake drum supplies cooling air to the drum.



A torsion bar replaces springs for racer's front wheels, each of which has independent drag links. Steering wheels have no play and are geared seven or eight to one; stock cars run about 12 to one.



Duraluminum wheels weigh only 16 to 18 pounds without tires, about half as much as steel wheels. The 5 1/2-inch-wide rim would support a 4,000-lb. car.



Ralph Hepburn's 500-hp. car, reportedly capable of 250 m.p.h., set new records in trials for the 1946 race and ran laps at better than 130 m.p.h. before it was forced out of the race. The all-time Speedway track record is 117.2 m.p.h., set by Floyd Roberts in 1938 in a car powered with a four-cylinder Offenhauser engine. Roberts was killed in 1939.



Edvard Stomper Memorial Trophy for the winning car's nursemaid, established in 1946, was the first formal recognition of master mechanics' role.

rolling again. He promptly stood on it. His margin of victory was only one minute and 48 seconds. Even so, that was a bit more comfortable than his two-second victory in 1937.

Bad Breaks and Good Ones

Nobody, of course, can foresee the bad breaks, not even the smartest of the master mechanics. Cars collide. Drivers lose them on turns and smash into the concrete retaining wall. Etched on the Speedway's north turn are the broadside wheel marks of a racer, the calling card left by Mauri Rose's mount last year. Ralph Hepburn set a new one-lap record of 134.446 m.p.h. and a new four-lap record of 133.944 in his qualifying trials, only to have a broken crankshaft in the actual race.

Then, of course, sometimes men make their own breaks. In the first revival of the 500 since the war there was a severe shortage of good babbitt metal for bearings. The engines of the racers obviously were going to suffer as a result. But not Cotton Henning's machine.

"Lemme see," mused Henning. "Didn't I have some babbitt put away around here someplace before the war?"

That's right, he did.

Cotton Henning is more than a master mechanic. He is a symbol. With the wisdom of 22 years at the Speedway, he stands for the men who win the races.

From Mechanic to Owner

Henning began coming to the Speedway back in 1921, and in the two-man-car days rode in the 500 as a mechanic. He has raced at the side of Peter DePaolo, Joe Thomas and Frank Elliott, all names in the Speedway firmament. He has nursed the mounts of Al Miller, Chet Miller, Russ Snowberger, George Connor, Meyer, Horn and Shaw and has produced four Speedway winners. This is an important year for Cotton Henning. Now he is the owner of a racer. He bought the Maserati that carried Shaw to victory on two successive years. But he is still his own master mechanic.

"Once a mechanic," he says, "always a mechanic."

It must be true. Last year a visitor at the Speedway the day before the race asked, "Who's the fellow in the business suit over there with his head under the hood of that racer?"

"Oh, him?" was the noncommittal reply. "Man named Shaw. Wilbur Shaw." **END**



RYAN XF2R-1. The Navy's newest Fireball is another hybrid—it has a General Electric TG-100 prop-jet gas turbine in front of the pilot and a J-16 thermal jet behind him. The shark-nosed plane is expected to reach the 500-m.p.h. range.

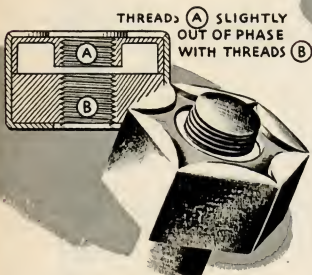
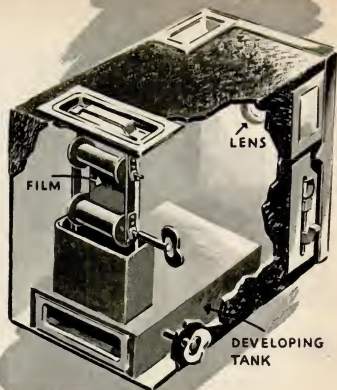
PLW-Up



NEW IDEAS from the INVENTORS

Camera Holds a Darkroom.

For the convenience of photographers who have neither time nor space for a darkroom, Clifton V. Berry, of West Haven, Conn., has patented a small, snapshot-type camera that features its own built-in developing tank. Shown in the cutaway view at right, the tank is a separate unit mounted on the floor of the camera and opening at its rear. After the roll of exposed film has been removed from the top, the camera is turned lens downward. This puts the tank in an upright position, ready to receive the film. Protected from the light by a sliding shield, the exposed film is then inserted in the tank.



Nut Locks Itself on Bolt.

Designed not to work loose, a nut invented by the late Albert C. Lusher, of Waterbury, Conn., is composed of two identically threaded but slightly out-of-phase parts. The friction set up by the two parts, which press against the bolt's threads like two separate nuts forced together on a single bolt, is sufficient to prevent the nut from loosening.

Prefabs for Dogs.

Not to be outdone by his master, Fido will enjoy the convenience of a prefabricated doghouse if an invention of John J. Latura, of Memphis, Tenn., is put into use. Shown in finished form at right, it is constructed of six one-piece, prefabricated floor, roof and wall sections, easily assembled with few tools. Interlocking metal joints in all of the parts, designed to slide together, prevent the wood from warping and make nails, screws or other fasteners unnecessary.



Pocket Eye Aid. Foreign particles are removed from the eye by a replaceable loop of delicate hair in the instrument pictured at right, patented by Clara Andrzejewski, of Chicago, Ill. Looking like a fountain pen, it also has a container that releases eye lotion directly into the eye when desired and an adjustable magnifying glass to help locate the foreign particles.

MAGNIFYING
GLASS

REMOVABLE
CAP

LOOPED
FILAMENT

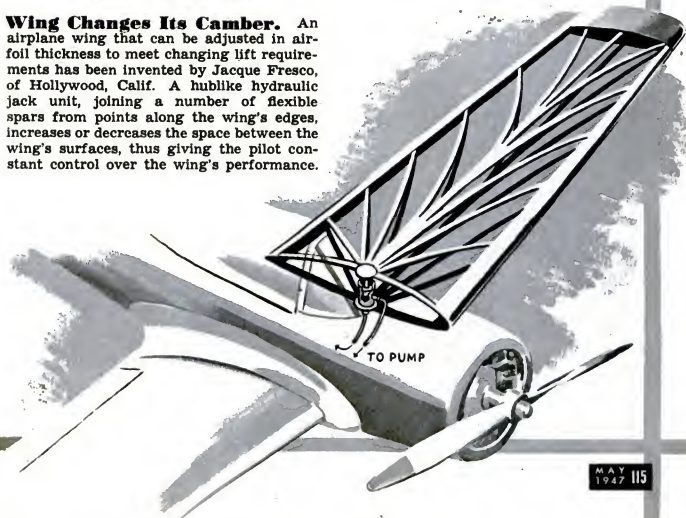
MAGNIFYING
GLASS SLIDES
ON BARREL


PLUNGER
RESERVOIR
FILLED WITH
EYE LOTION



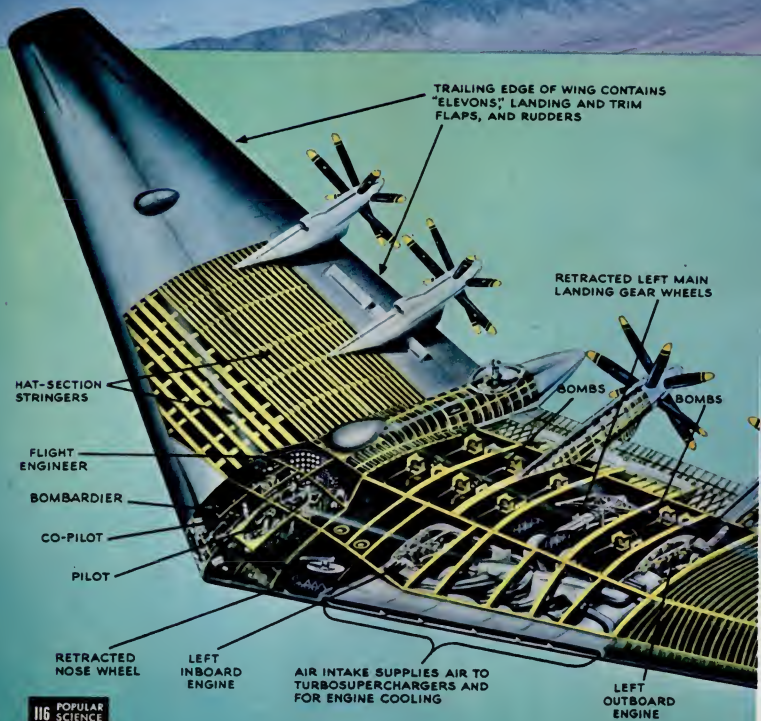
Wristband Cigarette Case. A cigarette and match are made instantly available in the wrist container for cigarettes shown at left. Invented by William E. Celestin, of New York City, it is composed of two layers of individually sealed, waterproof cylindrical pockets mounted on an elastic wristband. Each of the pockets, which may be opened one at a time by individual tear strings protruding from the top, contains one cigarette and a match. The container can be made to hold up to 40 cigarettes.

Wing Changes Its Camber. An airplane wing that can be adjusted in airfoil thickness to meet changing lift requirements has been invented by Jacque Fresco, of Hollywood, Calif. A hublike hydraulic jack unit, joining a number of flexible spars from points along the wing's edges, increases or decreases the space between the wing's surfaces, thus giving the pilot constant control over the wing's performance.





TINY TIM TAKES OFF. High above the vast Naval Ordnance Test Station at Inyokern, Calif., this Corsair fighter is being left behind by one of its 12-inch Tiny Tim rockets, fired a moment before.





VJ-21 MAKES ITS BOW. With a 75-hp. engine atop its wing, the Valmer Aircraft Company's new three-place personal plane has a cruising speed of 110 m.p.h. and a 500-mile range. Prototype has a single main wheel and small retractable wing wheels (one of which is visible in top photo), but production models will have fixed tricycle gear. Lower photo shows the designer, Valmer Jensen, entering cockpit of the 1,350-pound craft.

HOUSING FOR COAXIAL SHAFTS OF CONTRA-ROTATING PROPELLERS

RIBS

AUTOMATIC SLOT DOOR CLOSSES AT HIGH SPEEDS, OPENS AT LOW TO GIVE BETTER CONTROL

LOOKING INTO THE XB-35. Northrop's engineers faced a complex problem when it came to stowing a huge bomb load, a mass of operating mechanisms and 15 men inside the Army's Flying Wing. The cutaway drawing of the left indicates how difficult the job was—and how the engineers tackled it. Some of the crew positions are shown; other stations, plus sleeping quarters, are also in the center nacelle (PSM, Jan. '47, p. 95).

Everybody has his own pet idea of some gadget he would like to see in general use. What is YOURS? *Popular Science Monthly* will pay five dollars for every such suggestion that its editors decide to publish. Suggestions cannot be acknowledged or returned.

I'd like to see them make

Cartoons by SYD LANDI



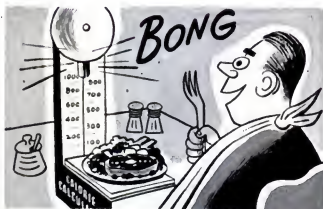
Photographic Guns. A camera attachment for rifles and shotguns would give the hunter evidence for doubting friends, declares John Manta, of Peikie, Mich.



Winding Bed Covers. Separate blankets that roll up at the foot of the bed would satisfy both husband and wife, thinks Frank Kelley, of Fairfield, Conn.



Adjustable Steering Wheel. To make getting in and out of the driver's seat easier, M. Garson, of Brooklyn, wants a steering wheel that will bend out of the way.



Calorie Calculator. A device for counting the calories in a meal would insure a proper diet and also spare the figure, says Mrs. T. M. Edwards, of San Mateo, Calif.

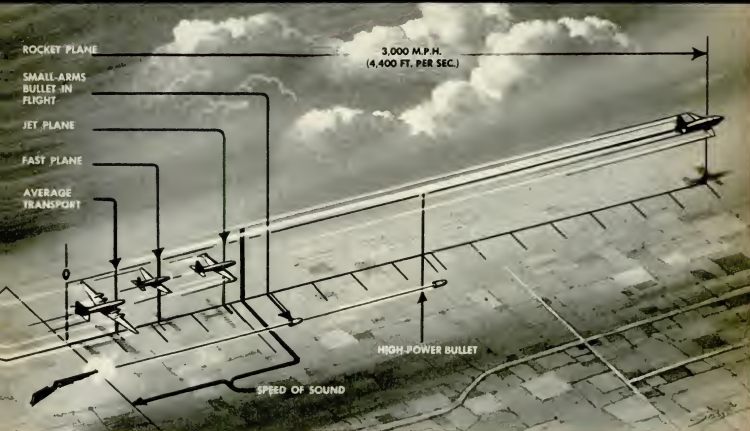


Keyless Locks for Cars. To avoid the nuisance of lost or forgotten keys, Joseph Marymont, of Elizabeth, N. J., suggests combination locks for the doors of cars.



Rubber Shampoo Bottle. Soap-blinded shampooers could drop it on the floor without hunting for a place to put it, says Walter Bartlett, of West Creek, N. J.

HOW FAST Is 3,000 m.p.h.?



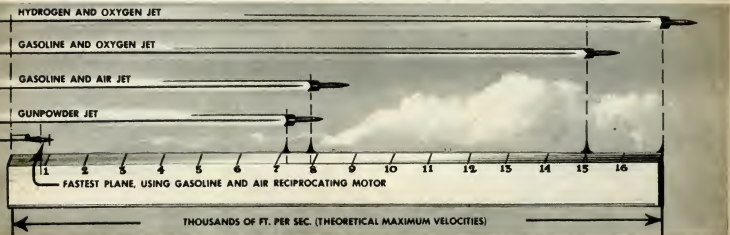
A CENTURY ago, "a mile a minute" was just a phrase that meant high speed; few people could visualize exactly how fast it really was. Today, almost every driver knows what 60 m.p.h. is like. We have "conceived" that speed. Perhaps in the near future we shall be able to conceive 200 or 300 m.p.h., but the speeds of stratospheric rockets will for a long time be nothing but figures. Two, three and four thousand m.p.h. are too fantastic to be grasped by most

Shown below are maximum fuel-reaction speeds in a total vacuum. Note how fastest plane with reciprocating gas engine would be left far behind.

Jet planes are nearing the 900 f.p.s. pace of small-arms bullets. Jet rockets are much faster; present ones could circle earth in less than seven hours.

men's minds today. Look at the drawing above and see how a mere 3,000 m.p.h.—the average lower speed for a coasting V-2 rocket at its peak altitude—compares with some with which we are more familiar.

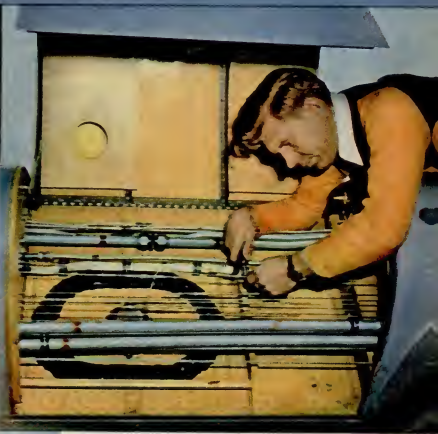
All the speeds we know best are limited by atmospheric resistance; even the V-2 is retarded by air. Without air, speeds become almost unlimited, as shown in the diagram below, giving theoretical speeds for rockets and airplanes. The fastest—17,000 feet per second—would be about 11,000 m.p.h.!





'Pioneer' for Frontier Flying

The new Northrop Pioneer, first new trimotor plane in many years, is a flying workhorse built for rugged frontiers with small fields and few repair shops. It takes off in 700 feet with full 10,600-lb. useful load and needs a minimum of servicing. Range is 1,750 miles and top cruising speed, at 10,000 feet, is 185 m.p.h.



To simplify repairs, the wing's leading edge is hinged in sections to expose color-coded wires, fuel lines and control cables.

Fueling through right landing strut (at left) simplifies servicing. The fixed landing gear lowers speed but saves 400 lbs.

Bulky freight or 30 passengers can be carried in the cabin shown below. Even 36-foot pipe can be loaded through nose.



Who's Who in Foreign Air

YOU'LL find these insignia on air liners all over the globe. Representing some of the outstanding foreign air carriers,

their colorful symbols portray maps, birds and beasts, reflect national pride and confidence in the air age.



Mexico's eagle totes a map on the insignia of CMA—Compania Mexicana de Aviacion.



Norway, Sweden and Denmark share Scandinavian Airways Systems—hence, three shields.



Sabena emphasizes the colors of the Belgian flag. Shield has star over a Belgian cross.



The kangaroo is, of course, Australian—the device of Trans Australian Airlines.



KLM—Royal Netherlands Air Lines—serves in Europe beneath a blue crown.



Serving Dutch colonies and countries outside of Europe, KNILM is a branch of KLM.



Also, Down Under, Australian National Airways indicates its operations area in red.



Iberian Airlines uses the colors of old Spain, plus a symbol of present Spanish government.



The winged sea horse of Air France flies over the North Atlantic and French possessions.



Swissair has the familiar white cross on a red of national flag, dating from the Middle Ages.



Called "The Springbok Line," South African Airways naturally sports a flying springbok.



With different lettering, this bird daubles for ABA, inside Sweden, and SILA, overseas.

The GROWING YEARS

1872: *H.M.S. Challenger*, during oceanic exploration, was first steamship to cross Antarctic Circle. Oleomargarine produced in France.

1873: Remington built first practical typewriter. Ammonia refrigeration begun.

1874: Soundings made for first Pacific cable. DDT synthesized.

1876: Bell invented telephone. Edison built his first phonograph.

1877: Presence of oxygen gas in sun discovered. Electric welding introduced.

1878: Edison invented a practical incandescent lamp. Calculating machine that solved differential equations invented.

1879: Benz's two-cycle engine appeared and cathode rays were discovered. Lockyer, accomplishing first transmutation of metals, obtained calcium from copper.



A crawl tread instilled on his son's bicycle tested the traction wheel patented by Henry Stith in 1880.

1880: Pasteur presented serum theory.

1881: Kelvin estimated size of atoms.

1882: Koch discovered tubercle bacillus.

1883: Antipyrine, first synthetic drug, developed. Rayon produced in England.

1884: Inventions: Mergenthaler linotype and smokeless powder. Waterman pen.

1885: Color photography introduced.

1886: Hertz created radio waves. Alternating-current system devised.

1887: Tesla invented split-phase induction motor. Burroughs adding machine introduced.

1888: First portable roll-film camera marketed. Dunlop's pneumatic tire patented.

1890: First four-cylinder automobile constructed in France.

1891: Telephone line laid: London to Paris.

1893: First Ford car built. Edison produced motion-picture machine.

1894: Lake constructed an even-keel submarine. Argon and helium discovered.

1895: Roentgen discovered X-rays. First Diesel engine built. Oxygen extracted from liquid air.

1896: Marconi established wireless commu-



The Maxim, invented about 1885, was the first true machine gun. Firing and ejection were automatic.

nication between England and France. Curtis steam turbine invented.

1897: Electrons discovered by Thomson.

1898: Radium discovered. First sensitized photographic paper produced.

1899: Two faint satellites of Saturn discovered by photographic method.

1900: First Zeppelin flew 17.8 m.p.h. Munroe reported "curious effects produced with explosive substances" that later made bazookas possible.

1901: Adrenalin isolated from suprarenal gland. Theory of mutation in biology announced, and research on proteins begun.

1902: Continuous-wave system for radio transmission invented.

1903: Wright brothers made first flight at Kitty Hawk. Cosmic rays discovered.

1904: A bulb detecting radio waves, forerunner of vacuum tube, invented.

1905: Einstein announced theory of relativity. Sperry gyroscope compass and stabilizer invented.

1906: First actual radio broadcast took place at Brant Rock, Mass.

1908: Novocain discovered.

1909: Peary discovered North Pole.

1910: Wireless message received in plane.

1911: U. S. air-mail service started. Rogers flew from New York to Pasadena in 82 hours. Amundsen discovered South Pole.

1912: Wilson cloud chamber used for nuclear-particle detection.

1913: Isotopes of elements discovered.

1914: Commercial radiotelegraphy inaugurated between San Francisco-Hawaii.

1915: Fokker invented mechanism for firing



Glenn Curtiss arriving at New York, May 29, 1910, on his flight from Albany that won \$10,000 prize.

of SCIENCE

A chronology of significant developments and discoveries during the last 75 years.

- a machine gun through plane propellers.
- 1916:** X-ray tube invented by Coolidge. Stainless steel produced.
- 1917:** Supercharger for airplane engines invented by Moss.
- 1918:** Sperry applied for patent on a gyro-scope robot plane.
- 1919:** Alcock and Brown made first nonstop transatlantic flight. First parachute jump from a plane.
- 1920:** De la Cierva built the autogyro. Election-returns program marked first radio broadcasting of spoken words and music.



"Hot Shot" robot plane of 1919 depended on timing gears to fly it over target and drop bombs.

- 1921:** Using principle of interferometry, Michelson measured diameters of the stars Betelgeuse and Antares.
- 1922:** Using facsimile system, pictures were sent from London to New York via Atlantic cable. Insulin isolated for medicinal purposes.
- 1923:** Synthetic rubber first obtained from butadiene. First nonstop transcontinental flight, New York to San Diego.
- 1924:** U. S. Air Service completed first around-the-world air tour (26,345 miles in 363 hours flying time).
- 1925:** Black-and-white caricatures sent during television experiments in Washington.
- 1926:** Plasmochin, a synthetic drug more powerful than quinine, discovered. Byrd flew over North Pole.
- 1927:** Lindbergh made solo flight across the Atlantic. Michelson clocked the speed of light at 186,284 miles per second.
- 1928:** Penicillin discovered. Radio beacon invented. Geiger-Muller counter for ionization developed.
- 1929:** Byrd accomplished first flight over South Pole. Zeppelin flew around world.
- 1930:** Nylon, Neoprene and high-octane gasoline produced. Planet Pluto discovered.
- 1931:** First photos showing curvature of earth made. Radar put to first practical use. Cyclotron invented.
- 1932:** Neutron and positron (positive electron) discovered.

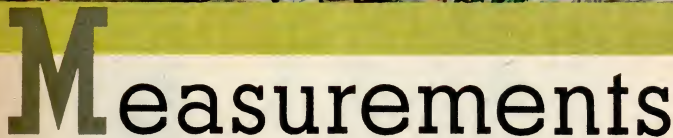
- 1934:** Curie and Joliot created artificial radioactivity.
- 1935:** Therapeutic use of sulfanilamide discovered. World's record balloon ascent of 72,934 feet made.
- 1936:** Multiple telephone plugs attached to seats enabled delegates to Third World Power Conference in Washington to hear speeches in any of official languages.
- 1937:** Whittle's first jet-propulsion engine operated successfully.
- 1938:** Uranium fission discovered. The *Queen Mary* made record Atlantic crossing in three days, 20 hours, 42 minutes.
- 1939:** First controllable-pitch propeller installed on Army P-36. DDT saved Swiss potato crop.
- 1940:** Sikorsky's helicopter made first successful flight. Omnidirectional radio beacon for planes perfected. First permanent U. S. radar installation on battleship *New York* tested in maneuvers.
- 1941:** Electron microscope used successfully after Pearl Harbor raid to locate metal splinters.
- 1942:** First self-maintaining nuclear chain-reaction pile begun at Stagg Field, Chicago. First U. S. jet plane flown. Sea-search radar accounted for more than half of U-boats sunk after mid-1942.
- 1943:** Work begun on Oak Ridge and Han-



A wingless "cylinder" plane, driven by jets of air, was suggested in the February 1934 issue of PSM.

- ford atomic-bomb plants. Skip-bombing technique used successfully by Allies.
- 1944:** Nazis dropped winged bombs (V-1s) on England, followed by rockets (V-2s). Streptomycin identified.
- 1945:** Atomic bomb dropped on Hiroshima, August 6. A new star, the Eagle, 80,000 times brighter than sun, discovered.
- 1946:** Atomic bombs dropped in Bikini tests. Radar signal sent to the moon and back. Artificially created snow fell on Massachusetts.

END



Even the butcher-shop scale that weighs

Primitive man divided up his days into hours by burning a piece of rope having



Unlimited

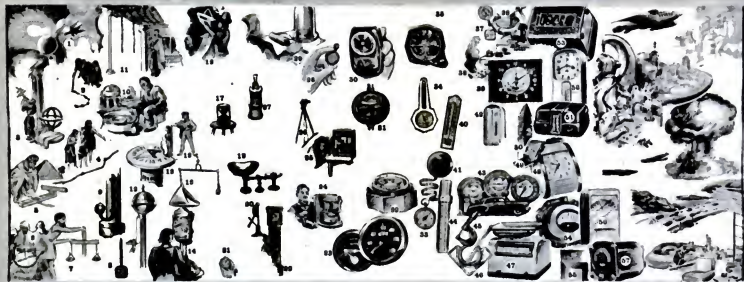
PSM **75**
ANNIVERSARY
FEATURE

equally spaced knots. Galileo's discovery of the pendulum in the 16th century made possible precise timekeepers—about as accurate as could be built until the recent development of electrically controlled quartz-crystal clocks. Now there are electronic stop watches that time differences of a billionth of a second!

The biggest advances in measurement have come in the past two centuries—partly because that period produced a host of new things to measure and to measure with. The discovery of electricity resulted in voltmeters, ammeters and similar devices. It also gave us the electron, which inside a vacuum tube performs all kinds of measuring no rule or scale could attempt.

The rise of industry in the same era also called for improved measuring devices. Invention of the vernier caliper and the micrometer about 100 years ago made mass production of interchangeable parts possible. Even then, mass production was generally limited to individual plants, for micrometers varied in adjustment—pistons

More than 50 measuring instruments—ancient and modern—are depicted in the mural planned by General Electric (above). How many of them can you identify? Check with the keyed drawing and answer list on the next page to see how good you are.



1 Sun and earth at the beginning of time. . . . 2 Primitive man telling time by the shadow cast by a rock. . . . 3 Early astronomical instrument. . . . 4 Stone Age men dividing the time by means of burning rope. Knots on rope indicate intervals of time. . . . 5 Early sun dial, Egypt. . . . 6 Early compass, Egypt. . . . 7 First scale for weighing solids. . . . 8 Cistern type of barometer, 15th century. . . . 9 Original thermometer, 15th century. . . . 10 Chinese water clock. When small dish fills with water, causing it to sink, the watch-boy strikes a gong. . . . 11 Chinese burning-rake clock protected from the weather. . . . 12 Later type of thermometer. Angel indicated temperature. . . . 13 Sun dial. . . . 14 First all-mechanical clock, 13th century. . . . 15 Chinese scale. . . . 16 First English yardstick. . . . 17 Haurglass. . . . 18 Astrolabe, an early version of the modern sextant. . . . 19 Early 19th century scale. . . . 20 Henley's electroscope (1772) for measuring electrical charge. . . . 21 The Nuremberg Egg, the first packet watch. . . . 22 Grandfather clock. . . . 23 Railroad engine instruments. . . .

24 Professor Thomson and the first AC meter. . . . 25 Thomas Edison and the first DC meter. . . . 26 Surveyor's level. . . . 27 Barometer. . . . 28 Early English exposure meter (1905). . . . 29 Faraday generating electricity from magnetism (1831). . . . 30 Modern photoelectric exposure meter. . . . 31 Hame electric meter. . . . 32 Modern marine compass. . . . 33 Pocket compass. . . . 34 Modern barometer and thermometer. . . . 35 Aircraft horizon indicator. . . . 36 Several industrial measuring instruments. . . . 37 Modern kitchen electric clock. . . . 38 Modern kitchen stove with time switch controls. . . . 39 Modern time switch for domestic use. . . . 40 Modern thermometer. . . . 41 Measuring tape. . . . 42 Thermostat for heat control. . . . 43 Automobile instruments. . . . 44 Slide rule. . . . 45 Micrometer. . . . 46 Protractor. . . . 47 Modern scale. . . . 48 Clock. . . . 49 Wrist watch. . . . 50 Tower clock. . . . 51 Radio. . . . 52 Thermostat, electric clock and thermometer. . . . 53 Cyclometer clock. . . . 54 Old-type electric meter. . . . 55 Gas meter. . . . 56 Time switch for industrial use. . . . 57 Aircraft direction indicator.

made in one factory might not fit cylinders built somewhere else because they were measured with different tools.

C. E. Johansson solved this problem in 1897 when he made sets of steel blocks that varied from their specified sizes by less than 2/1,000,000 inch. Using "Jo" blocks to check the accuracy of gauges, many complicated machines are now as-

sembled, without hand fitting, from parts made in dozens of scattered plants.

Jo blocks are a big step ahead of the Stone Age mechanic's marked stick. But still the search for greater accuracy continues. Measurements are unlimited, yes—if you're satisfied with a millionth of an inch or a billionth of a second. The scientists are not.

END

Science in 1872

By HAL BORLAND

PSM **75**
ANNIVERSARY
FEATURE

Its Growing Importance Brought About
the Publication of Popular Science Monthly

IN 1872, the year *Popular Science Monthly* was founded, Thomas Alva Edison and Alexander Graham Bell were 25 years old. Edison had already improved the telegraph and was experimenting, in his Newark laboratory, with other uses for electricity. Bell was teaching phonetics for deaf pupils in Boston. Samuel F. B. Morse died that year, and in the first issue of *The Popular Science Monthly* an editorial note said that "his name and work will help to save our age from oblivion in the distant future."

In England, James Clerk Maxwell, professor of experimental physics at Cambridge University, was completing his major work on electricity and magnetism. Herbert Spencer was completing the second section of his system of fundamental philosophy, which brought order into the world of scientific philosophy and thought. Charles Darwin was a tired 63; Thomas Huxley, 47.

In France, Louis Pasteur, who gave us serum immunity, was 50 years old and ranting vigorously at medical superstitions. In Austria, Gregor Mendel was virtually unknown, though he had published his master study of heredity six years before. In Russia, Dmitri Mendeleyev, at 38, had published his statement of the Periodic Law governing chemical atoms two years before. In Germany, Julius Sachs, the botanist, was a 40-year-old fanatic trying to convince his elders that his observations three years before proved implicitly that plants absorbed carbon dioxide and gave off oxygen both day and night—contradicting the venerable notion that at night the plants reversed themselves and absorbed oxygen and gave off carbon dioxide. In Italy, Guglielmo Marconi was not yet born.

Here in the United States, the first transcontinental railroad had been in use only three years. The country's population totaled about 40,000,000, and New York City had a population of 1,500,000. Ulysses S. Grant was about to be elected to his second

term as President. Europe was two weeks away from New York by fast steamship. A farmer living five miles out was an hour from town. Henry Ford was a nine-year-old schoolboy in rural Michigan.

A ferment was working. There was energy and the spirit of inquiry and development. Men were restless, both physically and mentally. Farmers were moving out toward the New West, and scientists were reaching into the unknown.

Many forays had been made into it, and information had been brought back. Few people had undertaken to organize this scattered information, however, and still fewer had pieced even related sections together into a usable whole. But the urge was there. Prof. W. Kingdon Clifford, of University College, London, was saying in

Breach of Sharp's breach-loading rifle, the "Old Reliable" of 1870s.





Hand-drawn steam fire engine: 1876.



Stereo-camera.



Graphoscope and stereoscope.

1872: "The subject of science is the human universe; that is to say, everything that is, or has been, or may be, related to man" (PSM, Nov. '72, p. 94).

The 19th century brought a rush of discovery. Dalton published the first table of atomic weights and founded the atomic theory. Prout theorized that all elements were built of the same ultimate material. Berzelius set forth the electrochemical theory. Oersted discovered magnetism, and Ampere related it to electricity; Faraday discovered electromagnetic induction—the foundation of the dynamo—and Daniell and Grove invented the electric battery. Cook, Wheatstone and Morse put electricity to work in the telegraph.

Liebig applied chemistry to physiology and agriculture. Helmholtz formulated the first law of thermodynamics. Simpson used chloroform as an anesthetic. Wallace and Darwin propounded the theory of evolution. Huggins photographed stellar spectra. Lister revolutionized hospital and surgical techniques by antiseptics. Stas made accurate atomic-weight measurements.

In almost every field of science we had new and swiftly increasing knowledge. We had developed a scientific method of inquiry and investigation. Pure science, the accumulation of factual knowledge and scientific speculation, was pretty well advanced. We were ready to put it to wide use.

First of all, we had power. Man's first source of power outside himself was in domesticated animals. Then he developed the water wheel, which was his major source of power until the 18th century, when steam was put to work pumping water from mines. Watt put steam pressure

PSM 75
ANNIVERSARY
FEATURE



Remington Type-Writer: 1873-74.

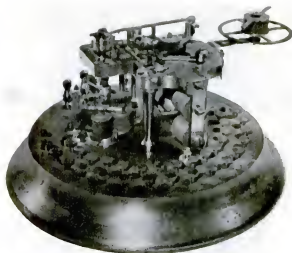
behind the piston; and steam wrought the Industrial Revolution. It was still the principal source of power in 1872. The principles of the electric generator were known, but it was Thomas Edison who was to apply those principles efficiently and make ours an age of electric power.

Power made it possible for man to develop tools, machines that could do heavier work and more of it than could be done by hand. Basic machine tools were in use before 1872—the lathe, the drill, the grinder, the milling machine, the die press, and the jig. And we had good steel in quantity. Bessemer in England and Kelly in America had invented in 1857 what is now known as the Bessemer process, and the Siemens brothers had invented the open-hearth method nine years later. We were beginning to make and use alloy steels.

We had compact high-power steam engines in locomotives, and we had thousands of miles of railroads. The telegraph had been in use since 1844. Steamships plied the oceans. We had the basis of an excellent system of communication. We had the camera, the telescope, the microscope.

Industrially, we had petroleum—but limited uses for it—illuminating gas, machines for making lead pencils and screws and horseshoes, the typewriter, the sewing machine, the rock drill, the rotary printing press, the electroplating process, and the knowledge of how to vulcanize rubber. We had the carbon arc lamp, and an inefficient electric locomotive had been built and run.

We had an industrial system and a market for its products, a swiftly increasing population, a rapidly expanding country, and new wealth from gold and silver mines,



Printing telegraph apparatus: 1872.



Edison tin-foil phonograph: 1878.



Singer sewing machine.



Edison dynamo: 1880.



Pioneer desk telephone set: 1877.

PSM photos taken by
W. W. MORRIS at the
Smithsonian Institution



Edison bamboo-filament lamp: 1880.

Daft electric fan: 1885.

Farmer platinum-filament lamps: 1859.

from timber, from industry itself. The Civil War so recently ended had marked the turn from an essentially rural economy to an urban industrial economy, from slave labor in the fields to paid labor in the factories. Industry needed science and all the practical knowledge science could muster. Science itself was ready to come out of the cloisters and take its place in the world.

In 1872, we had reached that point in time and development when a reservoir of knowledge was ready to pour its stream over the spillway onto the water wheel of practical application.

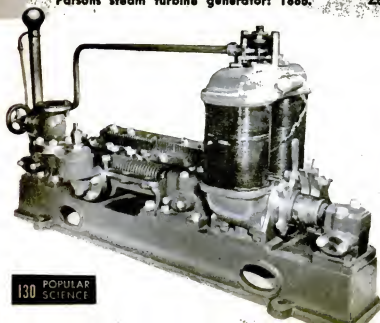
From this point on it would be impossible ever again completely to separate pure science from applied science. Back of applied science always would stand pure science, the search for fundamental truth and the establishment of scientific principles; but that truth and those principles would be interlocked henceforth. For man now had the most important tool of all—the scientific approach to his problems. From here on he would question, investi-

gate, and base his answer on honest inquiry.

Herbert Spencer was the philosopher-prophet of this new era. He saw, with more clarity than any other man writing at the time, the scope of science and the necessity of organizing scientific knowledge and applying it to all phases of life. He knew and followed the work of the major scientists of the day. He had practical experience as an engineer and an economist. He had written a book on education that laid the foundations for modern schooling. In the 1860s he began the series of scientific-philosophical works that mark a turning point in science itself. Darwin challenged venerable ideas and offered new ones. Spencer, starting from Darwin's theories, integrated the sciences, pointed out the common goal of all scientists, and pioneered the modern scientific approach to life and its problems. More, he made scientific knowledge and the scientific method understandable to the layman.

Three volumes of Spencer's major work had been published by 1872. The fourth

Parsons steam turbine generator: 1885.



Zoetrope, or "movies" with mirrors: c.1867.





Beeston-Humber racing bicycle: 1886.

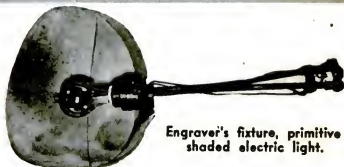


Duryea automobile: 1892.

volume, "Principles of Sociology," was published in America in *The Popular Science Monthly*. This publicity gave Spencer's philosophy of universal science its first widespread public. It stirred bitter controversy, being Darwinian. But it brought science out of the musty laboratories.

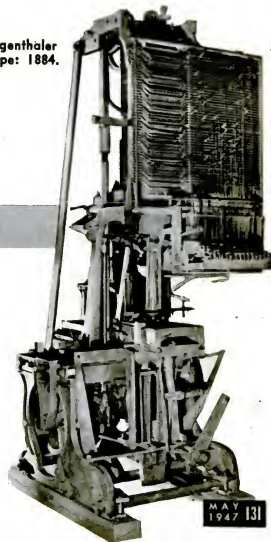
Rereading Spencer now is like reviewing well-known fundamentals, so completely have his ideas been accepted and woven into our basic knowledge. As recently as December 1946, James B. Conant restated one of Spencer's principles in his address to the American Association for the Advancement of Science, when he said, "The test of a new idea is not only its success in correlating the then-known facts, but much more its success or failure in stimulating further experimentation or observation which in turn is fruitful. This dynamic quality of science viewed not as a practical undertaking but as development of conceptual schemes seems to me to be close to the heart of the best definition (of science.)"

END

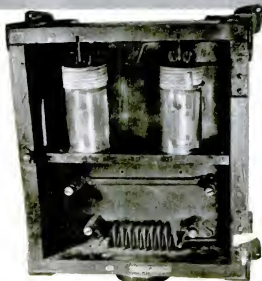


Engraver's fixture, primitive shaded electric light.

Mergenthaler
linotype: 1884.



Edison chemical meter: 1882-85.



MAY
1947 131

COVERS that came TRUE



This amphibious outho made o beachhead on PSM's cover in March 1916. Grown up into the famous DUKW—or Duck—it was used by the thousand in World War II, as described in PSM for April 1944.



This tremendous rivet squeezer was o good idea when it was shown on the cover for June 1920. In February 1947, PSM showed a hydraulic riveter that puts o 50-ton squeeze on railroad cars.

Popular Science

Founded MONTHLY 1872

Rides both
roads and air
See page 18



This concept of the roodoble plane goes back to the cover for March 1926. Southern Aircraft and the Fulton "Airphibian" are making it a reality—see PSM for April 1946 and February 1947.

POPULAR SCIENCE

MONTHLY

MARCH



ROCKING LANDSCAPE
TRAINS FLYERS INDOORS
Page 63

Learning to fly indoors may have seemed o crazy idea when PSM featured it on its March 1932 cover. World War II saw Army and Navy fliers do just this—PSM for April 1944 and October 1946.

Popular Science

FOUNDED MONTHLY 1872



When this appeared on the cover back in August 1921, prefabs were really dream houses. The August 1946 issue gave the picture a quarter-century later—with houses delivered in one piece, as above.

Popular Science

FOUNDED MONTHLY 1872



Radio fans and hams long dreamed of a really portable radio—as witness the cover of the June 1924 issue. PSM told how to make a walkie-talkie for licensed operators in September 1946.

POPULAR SCIENCE

JUNE

FOUNDED MONTHLY 1872



SEE PAGE 41

The flying wing may be one of the newest things in aviation, but PSM readers got an advance look at it in June 1933. In May 1946, PSMers read about a flying wing that really flies—the Northrop.

POPULAR SCIENCE

JUNE

MONTHLY



Streamlined Rail Car
Launches Giant Plover
PAGE 18

About in June 1937, somebody had a bright idea about using a car on rails to launch aircraft. It took nearly 10 years and a world war for the idea to develop—reported by PSM in November 1946.

These Men Helped Popularize Science



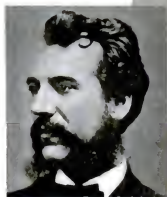
JAMES CLERK MAXWELL (1831-1879), British physicist, performed his greatest work in the field of electricity. An article entitled "The Theory of Molecules" appeared in the June 1874 issue, when he was at the height of his career. It was about this time that he expounded the law of distribution of velocities of the molecule. He also made valuable studies of color perception.

T. H. HUXLEY (1825-1895), although he never fully accepted the Darwinian principle of the modification of species, was a staunch supporter of Charles Darwin in the controversy that followed publication of "The Origin of Species." Among his contributions to PSM was an article "What Are Species?" in August 1876. He made many contributions in the fields of biology and medicine.



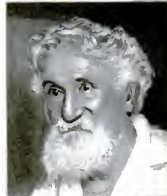
LOUIS PASTEUR (1822-1895), French chemist, is best known for the development of a curative and preventive treatment of hydrophobia, a subject treated in the July 1884 issue of PSM. He developed an anthrax serum, and his experiments with fermentation not only led to the pasteurization of milk, but helped pave the way for Lord Lister's use of carbolic acid to exclude atmospheric germs.

ALEXANDER GRAHAM BELL (1847-1922) was born in Scotland. In 1872 he settled in Boston, where he opened a school for training teachers of the deaf. In 1876 he demonstrated an apparatus that was the prototype of the modern telephone. His PSM contributions in 1880-81 dealt with the production of sound by light and radiant energy. His later scientific efforts included studies of mechanical flight.



SAMUEL P. LANGLEY (1834-1906) first demonstrated the practicability of mechanical flight. In 1874 and 1885, articles by him dealing with another subject, infrared rays from the sun, appeared in PSM. His experiments with an "aerodrome" in 1903 failed, leaving the honor of the first powered airplane flight to the Wright brothers, but eight years after his death the Langley machine was flown.

HUDSON MAXIM (1853-1927), American inventor and experimenter with explosives. Curiously enough, he wrote an article in the October 1918 issue of PSM describing a ship he had invented that would be immune to explosives. He developed the first smokeless powder used by the U. S. Among his other inventions was "maximite," a high explosive enabling torpedoes to pierce armor before exploding.





THOMAS ALVA EDISON (1847-1931), American inventor who became one of the best customers of the U. S. Patent Office, taking out more than 1,000 patents. In a PSM article in May 1922, he expressed doubt about freeing

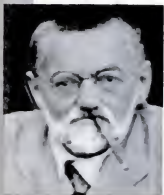
atomic energy.

"I just can't see that yet," he said. "Nevertheless, some fellow may come along tomorrow and do it."



HERBERT HOOVER (1874-), 31st president of the United States, was originally a mining engineer and technical expert, but after World War I he devoted his efforts to a career in public life. As Secretary of Commerce, he predicted in an article written for PSM in July 1922 that speech,

not music, would eventually become one of the most popular features of radio broadcasting.



CHARLES STEINMETZ (1865-1923), the German-born electrical genius, was associated with the General Electric Company during most of his life in this country. He considered his three greatest scientific contributions to be: investigations of magnetism, alternating current and lightning. It was on the

last of these that he wrote for PSM in 1922; his article dealt particularly with lightning's effect on radio reception.



NIKOLA TESLA (1856-1943), American inventor born in Yugoslavia. Specializing in electricity, he wrote an article for the 50th anniversary issue of PSM (May 1922) forecasting the future of wireless communication. "It will soon be possible," he wrote, "to see as well as hear by means of electricity.

"Television' will be employed as generally as telephoning." Tesla achieved many major electrical advances.

LUTHER BURBANK (1849-1926) conducted hundreds of thousands of experiments with all kinds of plants, producing a series of "new creations." In the April 1923 issue of PSM, he compared his work to improving "human plants." "In the development of plant life," he wrote, "lies a great, if not the greatest, object lesson for human beings."



HENRY FORD (1863-), father of the light, low-priced car and the assembly line that made it possible, turned out his first Model T in 1908. Although it took seven years to produce the first million cars, by 1926 his company was making two million cars a year. In an article for the July 1922



issue of PSM, Ford discussed one of his favorite subjects: agricultural-industrial communities.

OTHER CONTRIBUTORS TO POPULAR SCIENCE

Among the other noted men who wrote for PSM during the past 75 years are:

Herbert Spencer, Charles Darwin, Charles F. Kettering, Admiral Richard Byrd, "Eddie" Rickenbacker, Vilhjalmur Stefansson, William Beebe, Camille Flammarion, John W. Draper, Norman Lockyer, Simon Newcomb, Henry George, John Tyndall, John Lubbock, James G. Frazer, William Huggins, William Gladstone, John Dewey, John Burroughs, William James, William Thomson, Frank Chapman, Thorstein Veblen, Fridtjof Nansen, Cesare Lombroso, Flinders Petrie, Havelock Ellis, Edward Pickering, Alfred Russell Wallace, Percival Lowell, Simon Lake, Gen. "Billy" Mitchell, Glenn Curtiss, William Jennings Bryan, and William Coolidge.



E. L. Youmans

EDWARD LIVINGSTON YOUNG, 1821-1887

Founder, First Editor of Popular Science Monthly

America's First Evangelist of Science

He founded Popular Science Monthly to bring science to the American people.

By Roger Burlingame

IN THE winter of 1842, a young man of twenty-one walked dangerously in New York City. Others crossed the streets thoughtlessly enough through the slow, horse-drawn traffic, and were not greatly disturbed if they lost their way on a street ending in a river. But to Edward Livingston Youmans, even in the bright New York noon, every step was perilous for he moved in perpetual twilight. He could see dark objects dimly; he was aware of reflections of sharp light, and his senses of touch, hearing and smell were keen. But for all normal purposes he was blind.

He strayed from his course this day and his combined senses told him he had come to the waterfront. As he felt his way along it, he heard a splash and a cry for help. Instantly, Youmans groped about until his hand met a chain that was fastened to a wharf post. Gripping it, he lowered himself into the icy water and held up the drowning man until help came.

The exposure sent him to the hospital. When he began to recover, he found that the shock had robbed him even of the twilight; he was totally blind.

This incident—almost incredible as we first meet it in John Fiske's biography of Youmans—fits plausibly into the complete

picture of an almost incredible man. For Youmans' whole story is one of courage in the dark—not the darkness obscuring his eyes, but the darkness of ignorance, superstition, traditional prejudice. He was the missionary of science in the world to which he was born.

It is difficult now to reconstruct that world. A stone's throw from New York State's Route 50, where a stream of fast-moving cars runs today between Schenectady and Saratoga Springs, Vincent Youmans had a wagon shop. It was a center of news, gossip, political and religious debate in the 1830s. To it the outlying farmers brought their slow wagons with wheels and axles distorted by the rutted roads, and talked to the accompaniment of a hammer ringing on the anvil.

A Youthful Individualist

Edward, a normal child with an exceptionally strong physique, was something of a phenomenon in this community. He rebelled against the crude discipline of parrot-memory in school. He took the side of a pastor ostracized in the village because he had voted in a state election. He listened eagerly to the talk of a "free thinker" who was sinful enough to doubt the story of Genesis. At 10 he attached himself to a school outside the town because the teacher,

"Uncle Good," taught as Socrates had taught regarding the human mind: as Youmans later put it, not as "a tank to be filled," but rather "an organism to be quickened." His curious, independent mind seized on chemistry, "natural philosophy," the persistent "why" of common things. He read in every spare moment, carried his books with him about the farm. At night he fought sleep, reading and writing notes and comments on what he read.

Candlelight Study Ruined His Eyes

This incessant study held other dangers than the theological ones his Calvinistic mother feared. In the long winter evenings light on the farm came from the fire or from a dim candle. He kept at his books in spite of eyestrain. At 14 his whole life was a violent conflict between this and what Herbert Spencer later called his "work-drunkenness." At 17, still trying to ignore his suffering, he entered Galway Academy, paying his way by teaching on the side. In six weeks he broke down, was treated with caustics and calomel by an ignorant doctor—and lost, forever, the sight of one eye.

Youmans' spirit met his blindness without despair. It introduced important factors into his life. One was a capacity for reflection, an important balance to his impulsiveness. Another was the help of his sister Eliza. She was an able critic and analyst, a tireless worker. In the weeks following his disastrous treatment, she read aloud to him. Among other things she read, secretly, a book Edward told her it was not prudent to leave "lying about the house." The book was *Vestiges of Creation*—so heretical that the author dared not sign it. Full of errors and half-truths, as Youmans later knew, it was his curtain-raiser to the drama of evolution that absorbed his life.

For 10 years the case of his eyes seemed hopeless. He went to New York, went from one oculist to another, steadily draining the small family funds. In these years there were periods of "twilight"—times even when he could read and write—and stretches of complete darkness. A Doctor Elliott kept up his morale by his confidence in an eventual cure. Meanwhile, he lived in cheap boarding houses, attached himself to a group of other blind men, charmed them by his talk, his humor, his astonishing knowledge. He paid his way by composing advertisements for a druggist, supervising men working on Dr. Elliott's home, teaching a mem-

ory course. He invented a device to guide his hand in writing; some of the work he did with its aid, he sold.

Twice when he had a book ready for publication, a book by another author appeared with almost precisely the same scope and content. It was like finding that one's inventions had been patented only yesterday by someone else—a common occurrence in a time when all the best minds were groping in the same direction.

It was not an improvement in his eyes that brought Youmans success; it was success that brought the eyesight. That, anyway, was the doctor's belief, and in the light of modern "somatic" medicine this is understandable.

The thing that brought him money and fame was a chemical chart. Eliza had helped him construct it. His old distaste for crude teaching had inspired it. He wanted, too, to fill the gap left in schools by lack of laboratory equipment. The chart, five feet long and four wide, contained some thousand diagrams in 16 colors. The common elements were represented by variously sized and tinted squares; lines from them joined in graphic representations of compounds. It rolled like a map and, when hung on the wall, was visible to a large class. This graphic method with charts, diagrams, pictures, was basic in all Youmans' thinking "So," as he told Eliza, "that the whole could be learned in the quickest possible way and without reference to text, which loses time."

Linking Chemistry to Life

With his energy renewed, he followed the chart with the *Class-Book of Chemistry*. Contrary to the pattern of current education, with emphasis on disciplinary dullness, it made the subject interesting, connected it with the common experiences of life. Its introduction committed the heresy of suggesting that the study of nature is congenial to the young mind and "one of the purest sources of pleasure." Fiske speaks of the *Class-Book* as Youmans' germinal book. "Its reception showed him his strength and his true field. Thenceforth his career was that of breaking the bread of science to the multitude."

Its quick success ended the darker phase of Youmans' life. It had been a bootstrap-lifting phase, a lonely fight against the threat of total moral annihilation, but it had taught him a great deal. He had felt the ignorance

of science in hard impact upon his own body. He had been thrown constantly with people such as the blind men at the boarding house, to whom he had explained what he knew in the simplest, universal terms. He had learned to be tolerant of prejudice—not to hurt people and thus close their minds against him. His earliest environment had showed him the breadth of the gap between Calvinism and evolution. This was why he so often approached the popular teaching of science in *religious terms*. In combination, these things made Youmans a great teacher of the people.

Science Remote from People

Science in the mid-century was a snobbish business. Important English physicists, including Newton, Davy and Faraday, had told their achievements only to the Royal Society. Scientists generally distrusted the masses (partly because of religious opposition) and liked to protect the aristocracy of their studies from vulgarization.

In England, Herbert Spencer was working in this rarefied atmosphere when his extraordinary theory of evolution first came to Edward Youmans' attention. To Spencer, not only had physical life evolved, but so had all the sciences, all knowledge, human society—all according to a similar scheme. From the simple nebular, homogeneous state (as astronomers imagine the once-gaseous earth) into diverse, compact and complex entities, everything had moved and was continuously and forever moving. So, too, the human studies of philosophy, psychology, biology and sociology, had evolved out of vague and simple forms. A certain realm was forever unknowable; on First Causes, for instance, Spencer thought we must all remain agnostics.

When Youmans came upon a review of one of Spencer's books in an obscure London periodical, he saw the immense possibilities such a scheme held for popular education. Here, for example, was something which need not conflict with true religion. Did we not all confess the unknowableness of God? Then, in a scheme which correlated all the forces, physical, psychological, social—each dependent on some other—he saw a break in the deadly categorical plan of current education in which mathematics, physics, chemistry, economics, ethics, government and political economy were taught as separate matters hanging in the air, so to speak, as if they bore no relation to one

another. But all this integration of physical and social science, which modern students take in their stride, was locked up in a little circle of English scholars. How to unlock it, how to spread it broadcast among the American people? The question, from that moment, obsessed Edward Youmans.

First he got Spencer's published books from England. The new principle stood out; it must be introduced to Americans and made a permanent part of American education. The books *must* be published here.

He wrote Herbert Spencer, a bold thing for any "Yankee" (as he called himself in the letter) to do in those days. Spencer replied with the cordiality of a man who intuitively recognizes a kindred, sympathetic mind. The books were published by subscription, Youmans doing much of the advance salesmanship.

Youmans' eyesight was partially restored, the "chart" spread his reputation, and in the meantime he had also begun lecturing. Traveling in the winter from one small town to another in the primitive trains of the day, driving through blizzards in sleighs, he went as far west as Minnesota. His lectures on "The Masquerade of the Elements," the "Chemistry of the Sunbeam," "Ancient Philosophy," "Modern Science," and the "New Philosophy of Forces" were packed with illustrations from everyday experience.



While blind, Youmans devised this "writing machine." Roller separated lines; bar guided the pencil.

Youmans got \$50, occasionally \$75 an evening, but paid his own expenses. One wild night he talked after the lecture to a young man who had driven 10 miles to get there. Youmans "commiserated his folly" in braving the storm.

"I would not," said the boy, "take \$500 for what I have learned this night."

We may imagine the audiences, the young absorbed faces, out in the new country hearing for the first time of the world of science beyond the horizon—remembering, as we must, that these people grew into the

generation that transformed the nation and brought it through science to industrial leadership. Lost in excitement, Youmans sometimes fell off the platform, made immense gestures, his voice rising to great volume—"a combination," Fiske called it, "of explosive animal spirits and eagerness with perfect grace and gentleness."

Sometimes a pastor would deliberately call a church meeting at the precise time

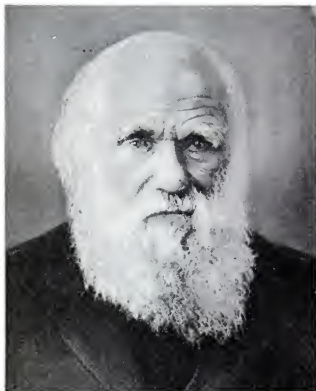
torial and literary work. Even these were strenuous enough. Trips to Europe, and long office hours, laid a tax on his strength that only the fire of his zeal could combat.

In these pursuits Edward Youmans was pre-eminent as an editor. He had written several books, to be sure, and many articles. Perhaps the most popular of all was the *Handbook of Household Science*. This was not a collection of recipes and practical hints, but a revelation of the scientific facts behind ventilation, heating, sanitation, cleaning, artificial light, food. It expressed convictions that the farm and home of his childhood had bred in him.

Aid for Spencer

The Spencer books that he edited moved slowly. Once, when Spencer became discouraged to the point of announcing that he could not go on with his life's work, Youmans got up a subscription among Spencer's American disciples and took to England a fund of \$7,000 in securities, together with a Waltham watch, as a token of their admiration. It was a delicate mission. Spencer was sensitive to such approaches; he had already declined an offer by John Stuart Mill to finance his projects. Youmans explained the securities as a fund that would lie idle unless Spencer used it, and so persuaded him. But when American papers played this up as a national gesture, Youmans answered the editorials, saying that science was international, that the subscribers were individuals and should not be tagged as an "American" group. With the revival resulting from Youmans' efforts, Spencer's works moved into a sale of more than 130,000 copies.

The two enduring monuments to Youmans' editorial career were the *International Scientific Series* of books and *Popular Science Monthly*. The Series began in that era of literary piracy, before the International Copyright Act, when anyone was legally free to bring out an American edition of a foreign book without paying a cent of royalty to its author. Youmans attacked the ethics of this widespread practice, and royalties were scrupulously paid. Thus he was able to break down much of the general overseas distrust of American publishers. He arranged for volumes by Tyndall, Huxley, Darwin, Liebig, Helmholtz and many others to be published simultaneously in America, England, France and Germany. During Youmans' life, 57 volumes of the



Charles Darwin upset concepts of man's origin, focused public attention on science as PSM was born.

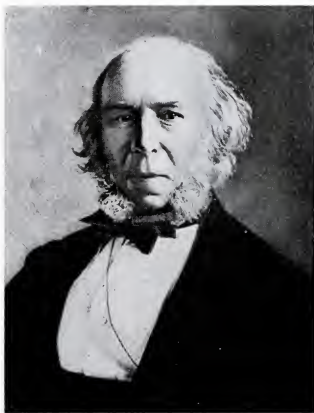
of the lecture and angrily harangue his congregation about the "sin" of those who "preferred science to Christ." When, after Youmans had met Spencer, he introduced the "horrors" of evolution that (even before Darwin) suggested man's kinship with the monkeys and the "survival of the fittest," the fight grew hotter and the press joined the clergy. Youmans met this conflict in the end by his insistence on Spencer's own belief that religion and evolution were reconcilable and by the persuasive argument that evolution was quite as beautiful a manifestation of Divine Will as the story of Adam and Eve.

Eventually, the lecturing told on his health. Every severe cold, every moment of exhaustion threatened his eyes. So he turned at last to the quieter pursuits of edi-

Herbert Spencer might well be called the co-founder of *Popular Science Monthly*; indeed, in 1908 the editor of PSM referred to the magazine as "one of the by-products of his (Spencer's) genius."

The first part of Spencer's series on "The Study of Sociology" opened PSM's first issue, in May, 1872. Youmans' reaction is recounted in Spencer's autobiography, which quotes this letter from the founder of PSM:

"A thousand thanks for your favour of March 13th, with article on 'Study of Sociology' enclosed . . . You did wisely in sending it, and I decided upon our course in 10 minutes after getting it. I determined to have a monthly at once and in time to open with this article. . . We have started a monthly of 128 pages . . . I am utterly glad that things have taken the course they have. I have wanted a medium of speech that I can control, and now I shall have it."



Herbert Spencer

International Scientific Series were published. Under his direction, they were all as popular presentations as their scientist authors could contrive.

A magazine had long been one of Youmans' dominant ambitions. For a time he worked as scientific editor of *Appleton's Journal*, a weekly with general circulation. It would not do. Subscribers objected to scientific articles in a paper they bought for literature and art. Youmans saw that he must attract a special public and work through it to the general reader. He persuaded the Appletons to publish *Popular Science Monthly*. "The work of creating science," he wrote in the first issue, "has been organized for centuries . . . The work of diffusing science . . . is clearly the next great task of civilization."

PSM Fought Prejudice—and Won

The magazine, which opened with a Spencer article, met the angry prejudice of the time. Its publishers were branded in the press as "infidels." Letters poured in from readers who confused agnosticism with

militant atheism. Yet the little paper continued. The increase in its circulation in three-quarters of a century from 12,000 to more than a million is evidence of the distance of Youmans' thought ahead of his own time.

Three Generations Ahead

And this is the overwhelming sense that comes from the review of his life. Youmans' mind moved on a level that was some three generations away. His concept of the "universality" of science belongs in today's laboratories. His ideas of the social sciences are incorporated in modern university study. His rebellion against "mental discipline" as an end in itself in secondary education is the basis of the progressive school. He anticipated international copyright by many years. But most vital of all to the American people, he made science democratic.

"Among professed worshippers of humanity" wrote Spencer in his autobiography, "I have not yet heard of one whose sacrifices on behalf of humanity will bear comparison with these of my friend."

END

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Like to See Edison's Laboratory?

This is where Genius labored when PSM was young.



Henry Ford reconstructed the Menla Park laboratory, the exterior of which is shown above. At the 1929 dedication Edison called it a true replica of the original he built in New Jersey in 1876.

The battery of smoking kerosene lamps at right produced the carbon for the Edison carbon-button telephone transmitter, which made the Bell telephone a practical success. Today, this transmitter is used almost unchanged, along with the Bell receiver.

PSM photos by HUBERT LUCKETT

Thomas Edison's historic Menla Park workshop has been reconstructed as part of the Edison Institute at Dearborn, Mich. Second floor interior, above, has original equipment with which Edison carried out experiments. Shelves are filled with every conceivable substance, from horsehair to precious metals, including bound volumes of PSM.





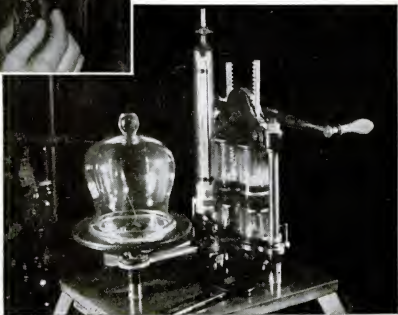
The Edison Electric Pen, shown at left, was a forerunner of the mimeograph. The inventor first manufactured it at Menlo Park. The pen is powered by a small electric motor that draws current from the wet-battery cells of the left of the picture. The stencil made with the pen is placed in the frame at right and ink forced through the perforations with a roller, making copies. Popular in big business offices, more than 60,000 of the pens were once in use.

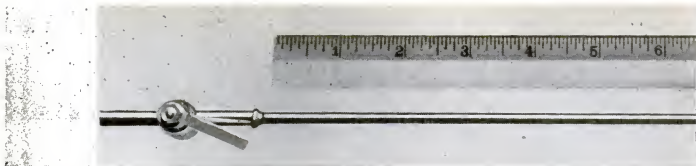
The stock ticker at right was Edison's third invention. With all its original parts, it still works as smoothly as when the inventor applied for his patent in 1869. The crude and undependable stock tickers then in use were soon replaced by the new machine, and money from the sale of stock-ticker inventions enabled Edison to open his own laboratory. At one time the inventor himself kept the tickers working.



Edison devised the Motograph Telephone Receiver, left, to get around patents on the Bell magnetic type. The transmitting current is fed into a revolving chalk drum. This pushes against a spring with pressure varying according to the intensity of the current. The spring activates a sound-producing diaphragm.

This bell jar and hand-operated vacuum pump were used by Edison during his early search for a suitable material for an incandescent light filament. It took thousands of experiments before he hit on a successful carbon filament. Although Edison did not invent the incandescent lamp, his high-resistance carbon filament, all-glass fused-sealed chamber, high vacuum, and sealed platinum lead-in wires combined to provide the world with a practical and efficient electrical lighting system.





The mysterious Hilsch tube in its original form as developed in Germany is about 20 inches long.

Maxwell's Demon Comes to Life

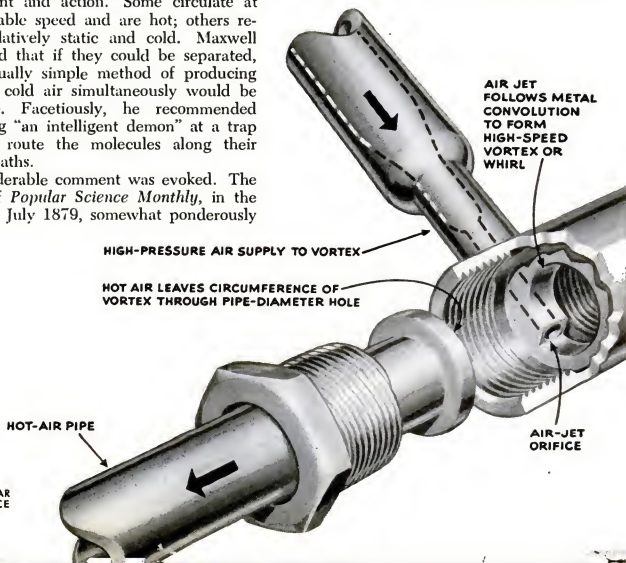
THE world lifted an eyebrow in the 1870s when James Clerk Maxwell, eminent British scientist, suggested the possibility of hot and cold running air from the same faucet. It took three-quarters of a century and an obscure German physicist to turn Maxwell's idea into reality. Success, however, has bred a minor laboratory tempest over exactly what has been wrought and for what it can be used.

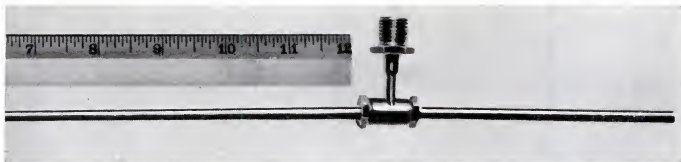
Maxwell's hint followed his development of "Maxwell's Law," which proved that the molecules in gases follow a pattern of arrangement and action. Some circulate at considerable speed and are hot; others remain relatively static and cold. Maxwell suggested that if they could be separated, an unusually simple method of producing hot and cold air simultaneously would be available. Facetiously, he recommended stationing "an intelligent demon" at a trap door to route the molecules along their proper paths.

Considerable comment was evoked. The editor of *Popular Science Monthly*, in the issue for July 1879, somewhat ponderously

commented: "This looks to us like a somewhat ridiculous way of evading the real difficulties in the explanation of molecular motions and their effects. . . . When men like Maxwell lend their sanction to such a crude hypothetical fancy as that of little devils knocking and kicking the atoms this way and that, in order to explain the observed changes of natural phenomena, we may well ask, 'What next?'"

The editor would have had a 65-year wait for his answer. It came when the Navy sent Dr. Robert Milton, a physicist, to Ger-





In operation, hot air flows through the long left arm of the tube, cold air through the short right arm.

many to investigate a report that the Germans possessed radically new equipment for cooling gases to within a few degrees of absolute zero. Dr. Milton set out prepared to bring back at least a ton of equipment to the United States. He found what he was looking for in a tiny laboratory in Erlangen. It was a tube about 20 inches long, less than half an inch in diameter and a few ounces in weight! Dr. Milton brought it home.

The tube, it was learned, had been perfected by Rudolph Hilsch, a bush-league German low-temperature physicist. Hilsch, who was integrated into the Nazi war effort, credits an unidentified Frenchman with discovery of the principle.

Here the muddle begins. Scientists themselves cannot agree on just how the tube works. Thousands of words seeking to re-

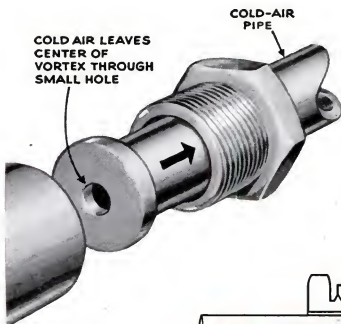
duce the mystery to formulas have been printed, along with detailed drawings of the tube. These are simple enough: The tube is divided into two arms of unequal length and width by a perpendicular, off-center jet.

There is a certain amount of agreement, however, on the tube's principle. William J. Taylor, of the National Bureau of Standards, offers this general explanation: Compressed air entering the jet, passes through a nozzle, speeding up and losing heat—the gain in velocity energy being made at the expense of the lost heat energy.

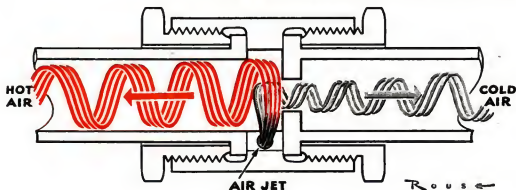
This fast, cold air is then slowed up by the spiral core of the tube. Some molecules drop toward the center. Instead of heating up as they lose speed, however, they pass along some of their energy to their next outer neighbor, and remain cool.

An additional cooling effect comes from the centrifugal force of the whirlpool itself. This force throws air molecules out to the edge of the spiral so that there are fewer molecules—and therefore lower pressure—in the inner layers than in the outer ones. When air moves from the high-pressure outer layers to the low-pressure inner layers, it naturally cools.

The result is a core of cold air at the center of the whirlpool and a border of hot air at the periphery. The shorter, smaller-



Cross section of the tube, below, shows how the air jet enters through hole, bottom center, and is spiraled by the shape of the tube. Drawing at left illustrates the tube's essentially simple construction.



R. O. U. S.

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bore arm of the tube communicates only with the center of the whirlpool and therefore draws off the cold air. The longer, larger-bore arm draws off the rest of the air—the hot molecules left at the periphery of the whirlpool.

Varying ratios of hot and cold air can be obtained by adjusting the stopcock at the warm-air end. The tube is capable of simultaneous temperatures of plus 106° and minus 56° F. At "hot" adjustment it can produce up to 350° F.

While the fundamental scientists have been arguing, the applied scientists of the refrigerating industry have been doing some experimenting of their own. Industry overlooks no bets that may involve discarding methods laboriously and expensively developed. At least three big concerns have had a look at the tube. At Westinghouse, Gaylord W. Penney, manager of the Electrophysics Department, has built a model three times the diameter of the original tube. He reports:

"Not efficient for refrigeration. The tube's

highest utility is as a laboratory device. For instance, it could be used as a cold trap for mercury. It could also be used to cool gases, such as helium, prior to liquefaction."

Physicists of other companies, together with those of the National Bureau of Standards, generally agree that the Hilsch tube has no particularly rosy industrial future for the time being. They point out that while the tube gives 15 to 20 times more cooling than the ordinary laboratory method—expansion of gas through a nozzle under the Joule-Thomson principle—it has refrigerating efficiency of only 20 percent, as against 70 percent in household refrigerators and close to 90 in larger cooling installations.

They are loath, however, to disregard the provocative commercial possibilities of the tube. A more highly refined model might attain the thermodynamicists' dream of a double-purpose unit, on which one switch produces heat; another, cold.

Maxwell and his intelligent demon are probably smiling quietly at some astral laboratory bench.

END



Mower Wheel Gets the Edges

LAWNS can be trimmed evenly right up to the edge of a flower bed with this one-pound aluminum edge-getter. It drops down to carry the wheel that ordinarily would hang

over the edge, thus keeping the mower level and its blades clear of the ground. When not in use, the attachment rides upright, being attached to a bolt supporting the roller. The device is made by the Barton Company, of Montrose, Calif.

Timber Rides Skyhook



TRIED out in the Oregon woods and now hard at work in North Carolina, a woodsman's invention is simplifying big logging operations. Appropriately called the Skyhook, the device rides on two large cables supported by pole trees about 500 feet apart and pulls itself along (right) on roller-bearing sheaves by means of two smaller traction cables. Fitted with tires (above), it can travel from one job to another at speeds up to 50 m.p.h.

The North Carolina installation is a 4,000-foot cableway along which the Skyhook carries average loads of 10 tons. It can do 35 m.p.h. on open spans, but has to slow down to 15 m.p.h. to pass the tree supports that hold the two 1½-inch cables. A 10,000-foot cableway is planned.



Fuse Looks for Target

ANTI-AIRCRAFT shells can actually look for their targets when guided by the optical proximity fuse that waits until it "sees" a plane before exploding the shell. This war-time development, recently revealed by the Bell Telephone Laboratories, uses a ringlike plastic lens near the tip of the fuse to focus light from the sky on a photoelectric cell in the center of the fuse. When the amount of light hitting the lens changes suddenly—that is, when the shell nears the target and is shaded by it—the resulting impulse explodes the shell.

Shown at the right are: (A) an optical proximity fuse assembled in its container; (B) the photo cell, on top of the amplifier housing, at the left, and the fuse cap with its ring lens, on the right; (C) the amplifier, left, and the protective wooden block that holds it; (D) the assembled amplifier unit, left, and the housing into which it fits.



NAVY Jones's arty Line



A NATURAL speaking tube thousands of feet below the sea will soon summon help for air and ship survivors from shore stations more than 3,000 miles away. Through this ocean "party line" the new Sofar system can detect the explosion of a single distress bomb thousands of miles distant and spot the position of castaways within a mile. Combined with Raser (PSM, Oct. '46, p. 134), it is expected to direct rescue ships to within a few feet of a bobbing life raft.

The long-distance yelp for help is plugged in with a three-pound TNT bomb, dropped overboard by the survivors of an abandoned airplane or ship. Water pressure automatically sets the bomb off at a depth of 3,000 to 4,000 feet. Because of the recently discovered speaking-tube effect at this level, the sound of the blast travels tremendous distances to hydrophones (underwater telephones) set offshore at the speaking-tube depth. Comparison of the times at which the explosion's sound arrives at several listening stations enables the operators to plot the exact location of the underwater bomb burst.

Pacific Stations Begun

The first installation of sofar (for Sound Fixing and Ranging) is already under construction. Four shore stations, at Kaneohe Bay and Hilo in the Hawaiian Islands, and Monterey and Point Arena on the California coast, will cover the wide, empty stretches of the Pacific that have claimed many victims from our busy air and sea traffic to South Sea bases and the Orient.

Sofar is the result of some ingenious reasoning back in 1937 by Dr. Maurice Ewing, associate in submarine geology at the famed Woods Hole Oceanographic Institute, Woods Hole, Mass., and professor of geology at Columbia University. Dr. Ewing was aboard the Woods Hole research ship *Atlantis*, investigating the sedimentary and

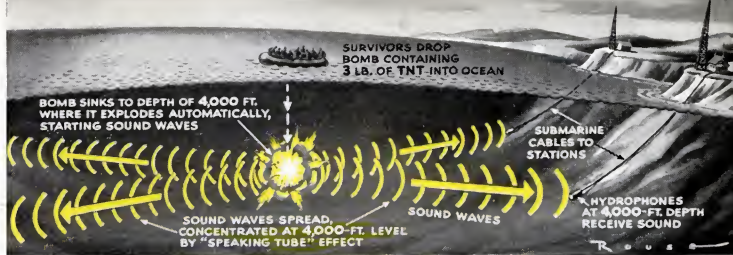
rock layers on the ocean bed three miles below by setting off small bombs on the bottom and measuring the resulting vibrations with a seismograph. One day he listened for the bomb burst by pressing his ear to the ship's rail. To his surprise, he heard the explosion and three echoes, the last of which must have bounced up and down seven times, traveling 21 miles.

Speed Varies with Depth

This observation led Dr. Ewing to wonder just how far an underwater blast could be heard in a horizontal direction with sensitive receiving and amplifying equipment. Knowing that the speed of sound in water increases with rising temperature and rising pressure, he calculated that sound would travel slower as the depth increased to 4,000 feet, because the temperature drops with depth. But below that level sound speed would increase again, since the temperature remains the same while the pressure increases. This meant that sound waves originating at the level of slowest speed, 4,000 feet, would always be bent back toward this level as their velocity was increased by warmer water or higher pressure above or below—just like the refraction of light rays as their speed is changed by a glass lens.

Further computation disclosed an even more interesting fact. Sound waves leaving the 4,000-foot axis at an angle smaller than 12° from the horizontal would never reach the surface or the bottom. They would be refracted back and forth across the axis and travel zig-zag fashion in a horizontal direction. In other words, the zone around 4,000 feet acts as a channel, directing a large percentage of all sound originating there along a horizontal "tube."

This channeling effect is so great that, theoretically, an explosion on the sound axis



might be heard 25,000 miles away if no land masses interfered. In actual test, a bomb set off near Dakar, French West Africa, was easily heard in the Bahamas, 3,100 miles across the Atlantic.

A bomb bursting within the channel produces an unusual, characteristic sound in the hydrophone. The fast rays making the widest zig-zags around the axis are heard first, even though they travel the longest route. Their intermittent beats build up gradually to a sharply ending boom—the slow sound ray that goes straight along the axis. The complete effect sounds like a kettle drum, slowly rising in tempo and volume to the finale of a cymbal clash. Because of this sharp cutoff, time measurements precise to 1/10 second are possible, permitting accurate location of the distress bomb—and the survivors.

Accidental false alarms from everyday underwater blasting are unlikely, since the characteristics of sound originating inside the channel are so different from those made outside it. Only an improbable coincidence

could produce an explosion at 4,000-foot depth that was not a distress call.

The sound channel remained little more than a scientific curiosity until World War II brought the need for better sea-rescue devices. Then the Navy assigned its Underwater Sound Laboratory in New London, Conn., to co-operate with Woods Hole in the development of sofar.

The instruments now being used are similar to those designed for sonic depth-finding and ranging (PSM, Nov. '45, p. 84).

With construction of the first sofar stations already under way, Coast Guard monitors will soon be listening in on Davy Jones's party line. Yet research continues. The system has been tested in tropic and temperate zones, but not in the polar regions, where future air routes may be busiest. Water in the Arctic and Antarctic is almost the same temperature all the way down from surface to bottom, and many authorities predict that there will be no sound channel there. No one knows for sure—but the Navy intends to find out. END

These Navy technicians, using information gained by bottom sampling and shorean positioning, are plotting an ocean-bed survey for sofar operations.

Nansen battles are lowered to obtain salinity samples at varying depths, as part of the process of determining the best zones for sound transmission.



Camera Coughs Out Finished Prints

YOUR present camera performs only one of many steps—developing, fixing, printing, and so on—involved in making a photograph. Edwin H. Land, 38-year-old president of the Polaroid Corporation, has invented a one-step process in which the camera does everything. With his camera, you snap the shutter and turn a knob; 60 seconds later you have a finished, dry print.

The Land camera takes its pictures in the conventional way, but inside it, in addition to the film roll, there is a roll of positive paper with a pod of developing chemicals at the top of each frame. Turning the knob forces the exposed negative and the paper together through rollers, breaking the pod and spreading the reagents evenly between the two layers as they emerge from the rear of the camera. Clipped off, they can be peeled apart a minute later.

Ordinary chemicals are used, but the negative is not transparent and light is not

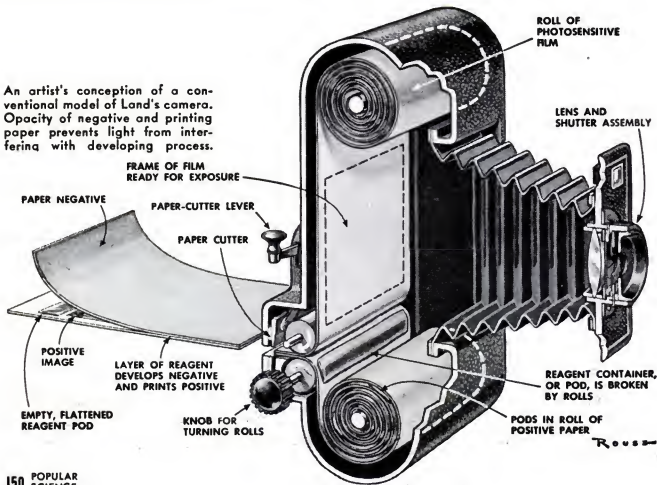


Land displays a one-minute photograph of himself. A model of his camera has been designed for large-scale production, but plans for it are undisclosed.

required for printing. The unexposed portions of silver halide are transferred from the negative to form the positive image.

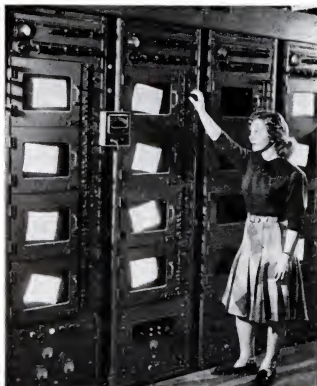
Land says that ordinary transparent film can be adapted to one-step photography, but he sees no need for it. If additional prints are desired, the easiest way is to make additional exposures. If necessary, the original print can be rephotographed.

An artist's conception of a conventional model of Land's camera. Opacity of negative and printing paper prevents light from interfering with developing process.





Blowing Big Bubbles. A glass blower (above) puts the finishing touches on the glass envelope for a giant 100,000-watt General Electric transmitting tube. The blowing keeps the glass from burning and maintains a constant air pressure within the tube.



Testing Television Tubes. Allowed to burn nearly 24 hours a day, these cathode-ray tubes (above) will last only two to four months, but their performance will provide GE engineers with valuable data.

Glass Spray Seals Tubes. Pulverized glass is sprayed on the metal base of an electronic tube (at left) in a new Westinghouse process. When baked and cooled, a thin, hard, airtight coating is formed.

AIDS TO MODERN LIVING



KNOTTY FURNITURE.

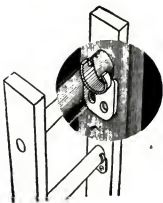
Carrying the decorative features of paneled living-room and den walls to the furniture itself, designers have now brought out chairs, tables, and other pieces in knotty pine. This wood takes a variety of attractive finishes. The room shown at right was a display at the International Home-Furnishings Mart, Chicago.



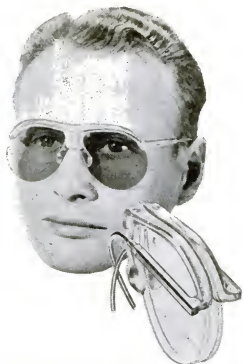
STEEL-AND-COPPER COOKER. This new pressure cooker is made of acid-resisting stainless steel and has a bottom covered with a thick sheet of copper to increase heat conduction. A hinged gauge lifts automatically at 15-lb. pressure. The cooker is in the copper-clad line put out by Revere Copper and Brass, Inc. About \$16.

CLEAR-PLASTIC RIVETS. Both solid and hollow fastenings are made up in colorless and tinted Plexiglas for use with light metals, leather, cardboard, rubber, upholstery, and sheet plastics. The rivets, shown at the right, are expanded and headed by heat rather than by hammering. Douglas Aircraft Company developed the rivets and two rivet guns for handling them.

RUNG SAVERS. Socket clips of heavy-gauge steel screwed or nailed to the sides of a ladder to support the rungs will add safe extra life to an old ladder, even if the rungs have rotted in their sockets. A curved lip is fitted under the rung to provide a saddle or socket extension reaching to sound wood. The rung reinforcements are manufactured by Reimann and Georger, of Buffalo, N. Y. They are made of a heavy-gauge sheet steel and are cadmium-plated to resist rust.

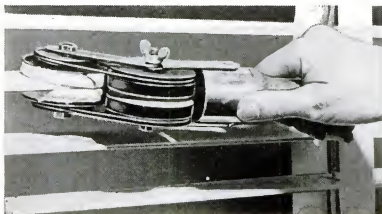
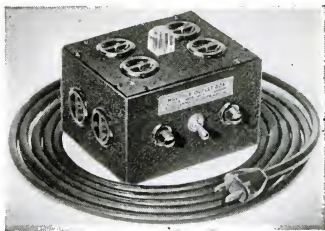


CASTERS LEVEL FURNITURE. Plastic casters, made in two parts, will level up chairs and other pieces having uneven legs and also steady furniture used on uneven floors. One section fitted with a screw is attached permanently to the leg, and a screw cap adjusts height. Levelor Corp., of White Plains, N. Y., manufactures the casters from Tenite.



FOLDING GOGGLES. Hinged at the bridge, new shatter-resistant plastic-lens goggles fold to less than the size of a cigarette pack. A stainless-steel rim extends across the top. Lenses are green. Watchemoket Optical Co., Inc., of Providence, R. I., is the maker.

EIGHT OUTLETS IN ONE BOX. This electrical unit, equipped with 12' of cord, is designed to provide extra outlets for the home or shop. In addition to conveniently spaced receptacles, it has a 1/25-watt neon pilot light that distinguishes between A.C. and D.C., a double-pole toggle switch, and a pair of 15-amp. fuses to guard against shorts and overloading. The box is enclosed in a 3" by 4" by 5" metal casing and weighs 1½ lb. It is a product of Allied Laboratory Instrument, Inc., of New York. Models are available for 115 and 230-volt use.



QUICK BLIND CLEANING. A set of pads on revolving disks cleans both surfaces of Venetian blind slats in one operation. Three sets of pads come with the roller—one for use with cleaning fluid, one for waxing, and one simply for dusting. They are of washable cotton. Warren Venetian Blind Cleaner Co., of Pittsburg, Kans., supplies the roller and pads along with a special cleaning fluid for the blinds.

AUTO IDEAS



VENT DEFROSTS WINDSHIELD. Slipped neatly under the hood, this flat aluminum vent channels engine heat against the windshield and dispels frost and sleet. Although flared at each end, the vent narrows to just a slight aperture at the point where the hood pins it down. It is manufactured by the Johnson Ladder Shoe Co., Eau Claire, Wis.



With this plastic top, you can get the same amount of sunshine as in an open car—but without the breezes. Windows raise and lower normally.

PLASTIC TOP. Vision in all directions is permitted by a clear plastic top manufactured for convertibles by the Wright-Austin Company, of Detroit. The Plexi-Top is held by four toggle clamps and does not necessitate removal of the regular canvas top. It has a roll shade to shut out the sun when desired. The top weighs 50 lb.



SPOTLIGHT ON ROOF. A streamlined movable spotlight for mounting on the roof of a car instead of through the corner post has been introduced by the Trippe Manufacturing Co., of Chicago. Operated by a control knob on the ceiling of the car, the light turns through a field of 270 deg. A switch on the knob turns the light on and off.

TWIN JETS WASH WINDSHIELD. With an automatic washer produced by the Trico Products Corp., of Buffalo, N. Y., you can keep your windshield clean while you drive. Vacuum-operated, the washer squirts twin jets of water or washing solvent on the windshield when you touch a dashboard button. The wiper then clears the shield. A 2-qt. reservoir is located under the hood.





Land Cruiser

IS DE LUXE HOME ON WHEELS

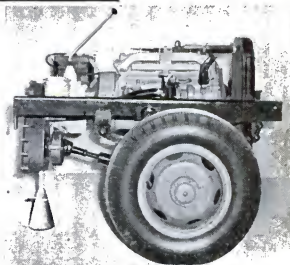
At home abroad. This 30' traveling home has all the comforts of a four-room house.

It gets its power from a front-wheel-drive motor built as a removable unit with the clutch, axle, and transmission.

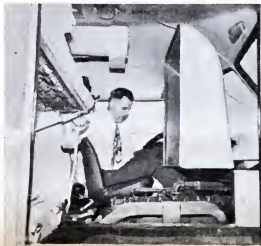
WHEN it comes to vacations, this land cruiser with a strong resemblance to a cross-country bus combines the speed of motor travel with the comforts of yachting. It will accommodate eight persons with such conveniences as a galley, lounging rooms, observation tower, sleeping quarters, shower, and intercommunication phones.

The de luxe home on wheels was built to specifications for Dr. H. J. Sealey, of Dumont, N. J., by the Linn Coach & Truck Corp., of Oneonta, N. Y. Its 125-hp. Hercules engine was put into a Linn front-wheel-drive unit and is accessible from inside, as in the Linn trucks, when an interior hoodlike covering is lifted.

Accessible from within the driver's cab, the engine is exposed for minor repairs and adjustments by lifting the inside hood.



Beds for two persons can be made up in the main living room, and there are sleeping quarters for six more. A shower, galley, and observation tower are included.



Tune Your Car for a Carefree Vacation

By R. P. STEVENSON

PSM Photos by ROBERT F. SMITH

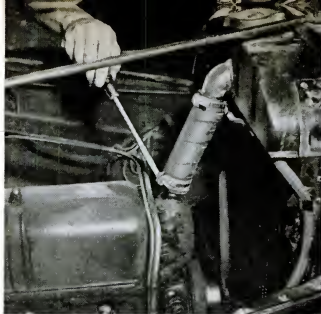
VACATIONS always are more restful and interesting if free of the cares of your everyday life. For this reason, it will pay you to become a worry wart for a week or two ahead of time, if you are planning a motor trip this summer, and check over your car to see that it is in the best possible condition. For some of the more difficult jobs, you probably will want to take it to your serviceman, but there are many things you can do yourself, some of them minor and routine but all adding up to greater effi-

ciency for your car and more travel comfort for yourself.

Such a pre-vacation checkup is particularly advisable if you are planning several days of steady driving, for minor defects that may not amount to much in short trips around home are apt to turn into major repair jobs under the stress of long runs. For example, you may have been getting along with brakes that are not quite equalized, or a grabbing clutch. On a long trip, bad brakes may damage your tires and it is possible that a grabbing clutch could magnify itself into a smashed transmission, rear end, or universal joint.



Before you set out, check the car thoroughly so it will not turn your trip into a series of garage stopovers. A can of motor oil stored with the luggage will help guard against burned-out bearings.



Hot weather and fast driving place a heavy burden on the cooling system. So tighten the hose clamps and adjust the fan belt, or replace it if frayed.



Also flush out the cooling system. Reverse flushing is more effective in cleaning out the corrosion, but a hose used in the old way will help a great deal.



With a wire brush, clean off the corrosion from the battery terminals. Then apply a light coating of petroleum jelly. Also check over the cables and be certain each one is making good contact.



Remove the mesh filter from the oil cleaner and wash the dirt from the filter with gasoline. Then dip it into a container of light oil and allow to drain for some time before returning to its place.

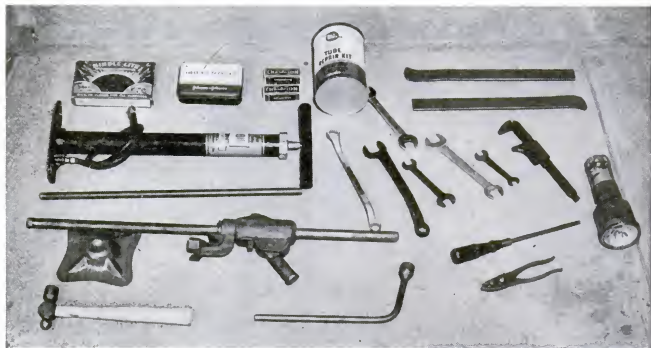
Before settling down to a consideration of the more serious jobs, like checking the brakes, adjusting the carburetor to give the best mixture for summer driving, cleaning the spark plugs, flushing the cooling system, and inspecting the tires, it would be well to give a thought to a few things that are so obvious that they could easily be overlooked.

You may *think* you are adequately prepared to handle a task such as changing a tire on the road—but are you? Check to be sure you actually have a jack, tire pump, lug wrench, tire iron, and tube-repairing kit in the car. Such equipment has a habit of getting left in the garage or cellar after being used for other jobs. Even at the last moment, you better take a look at the tire pump again, since Junior may have bor-

rowed it to inflate his bike tires or football.

While you are making sure of your tools, think about storing a gallon can of motor oil in the luggage compartment. It's sometimes a long distance between service stations—and that oil reserve could easily be the means of preventing your bearings from burning out. Incidentally, keep a close watch on the oil consumption for the first few hundred miles driven at good speed, for the car may have developed into an oil hog since your last long trip without showing it in routine day-to-day driving.

Before you set out, give your battery the same kind of check that you should anyway about every two weeks. See that the water level in each cell is at least $\frac{3}{4}$ " above the plates, adding distilled water if necessary;



Are you prepared for any emergency that might arise on the trip? Spread out your tools and equipment on the driveway and check them over to see that nothing essential is missing. In addition to the items seen here, a provident driver will take along chains, spare fuses, and extra bulbs for the accessory lights.

and take a hydrometer reading of each cell. Fully charged, the battery should have a specific gravity reading of 1.280 to 1.300. If the reading is below 1.250, have the battery recharged.

At the same time, clean any corrosion from the battery terminals with a wire brush, wash the posts and lugs with baking soda and water, and rinse with fresh water. A coating of petroleum jelly will help keep them clean. Go over the cables and be sure that they are in good condition, and that they make firm, low-resistance connections.

Unless you have done so quite recently, it would be well to change the crankcase oil and the transmission and rear-end lubricants, and have the car lubricated throughout. It's a good plan to refill the shock absorbers, too, and to replace any defective links. At the same time this is being done, make a painstaking inspection of the brakes, looking particularly for leaks in the hydraulic system. Have the linings replaced if you suspect they are worn to, or almost to, the rivets.

Go over each tire carefully for cuts, bruises, nails, and worn spots that may indicate unbalanced wheels, uneven brake action, or shimmy. Make this tire inspection after removing the wheels, and then transfer each to another position to get more even wear. On your pre-vacation visit to the service station be sure to have the wheels

checked for alignment, for there is nothing that will ruin your tires more quickly than improper front-end alignment.

On a long trip at high speed, the cooling system must work at its best. Hence, the radiator should be flushed thoroughly to remove any corrosive deposits that might eventually work loose and clog the system. There is a difference of opinion whether the permanent antifreeze mixtures should be removed during the summer, but even if you want to leave the mixture in, it is a good idea to remove it temporarily, flush the system, and replace the mixture. While working on the cooling system, also adjust the fan belt to the proper tension. Replace the belt if it shows any sign of raggedness or is oil soaked.

While it may be best to have an expert set the carburetor for the most economical performance, there is one seasonal adjustment on many carburetors that anyone can make with ease. This is an adjustment that in winter causes the acceleration pump to shoot an extra charge of gasoline to your cylinders when you step on the gas. For summer, this should be set to pump a smaller amount.

If your car has an automatic choke, as it probably has, you will find a tiny wire-mesh air filter inside the choke housing. Remove this and clean with carbon tetrachloride—or if it looks hopeless, throw it away and get a



After scraping carbon from the spark plugs, check the gap on each with a wire gauge. If adjustment is necessary, bend only the side electrode.

new one. Also remove the filter from the air cleaner, wash out the dirt with gasoline, dip the filter in light oil, and drain before replacing. Clean the oil-filler cap in the same way. The sediment bowl in the fuel pump is still another cleaning job you should take care of.

Spark plugs are deserving of special attention. Before touching them, however, carefully brush away all dirt so it will not fall into the cylinders when the plugs are removed. If a plug is found to be cracked, badly worn, or oxidized, replace it. If it's still in good condition, scrape the accumulated carbon from the electrodes and check the gap with a wire gauge, bending the side electrode only if any adjustment is needed.

Next, turn to the distributor, inspecting the housing for cracks. If the points are pitted, smooth them with a coil file or replace, remembering that an accurate setting is required for smooth functioning of the engine. It is essential, too, that the timing (that is, the distributor vacuum-advance) be exactly right since this is a prime factor in good performance, and good performance will be especially important to your peace of mind during a vacation.

On a long trip, it is remarkable how annoying you may find a little squeak that you scarcely notice while driving around home. So locate it if you can—and tighten up the joint or apply a little oil. In any case, apply a little graphite lubricant to the wedge-plate and dovetail assemblies of the doors. You may be surprised at what a difference this makes in giving you a quieter ride.

In addition to the tools and equipment previously mentioned, consider taking along

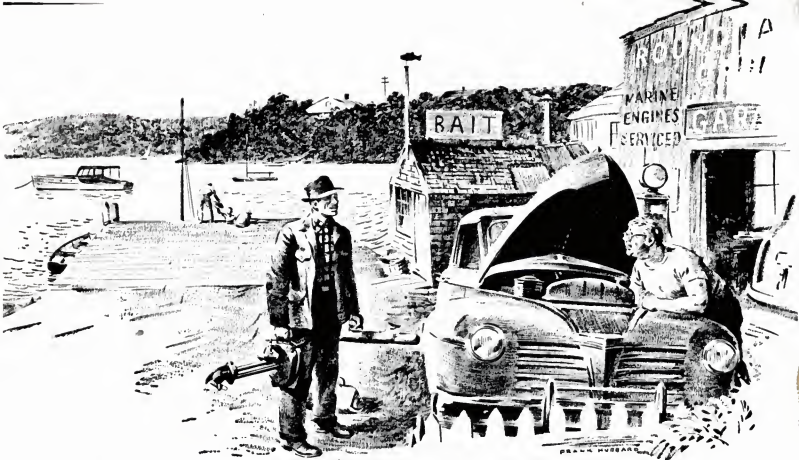
a good set of chains—for on side trips in some rural areas you still may get bogged down in mud or sand. And speaking of weather, you undoubtedly are hoping that the sun will shine throughout the trip. However, it may not. So why not check the windshield-wiper hose for leaks right now—and be prepared?

A provident driver, especially if the trip is to be in lonely country, also would have on hand such things as flares, duplicate fuses, and spare bulbs for the taillight, backup light, and dash light. A duplicate set of keys—door and trunk or spare—is another good idea, but don't carry them yourself. Give them to a companion—or wire them to some inconspicuous place on the car that's accessible from the outside to someone who knows where to look.

Lastly, if you are like most other people, your glove compartment probably could stand some attention. Clean out the mixture of bobbie pins, gum drops, old envelopes, and other debris that probably finds a haven there, and replace with insurance papers, several up-to-date maps, a flashlight, some spare matches and cigarettes, and any other personal items that will help bring you back alive and in good spirits. END



On a pre-vacation visit to your service station, have the wheels aligned. It is estimated that a tire $\frac{1}{2}$ " out of line is dragged sideways 87' each mile, reducing life of the tire 20 to 50 percent.



GUS Settles an International Incident

By MARTIN BUNN

STAN HICKS has a habit of acting first and thinking afterward. That's what he did late one afternoon when a convertible with its horn blowing continuously was driven up to the Model Garage. He dashed to the shop door, opened it, and motioned in the sheepish young man at the wheel.

Gus Wilson, intent at the workbench, looked up startled as the continuously blasting horn echoed in the garage. Then he hurried over, raised the hood, and deftly disconnected the horn relay. Quiet returned to the shop.

The driver climbed out—Paul Tarlin, a young man who's been going right up the ladder at our town's bank. It was the opening day of the bass season and his clothes told Gus that he'd been fishing. "Hello, Paul," Gus greeted him. "Get any bass?"

Paul shook his head. "They wouldn't

touch a thing," he said dourly. "Say, that's the second time the horn's done that. The first time my wife was with me, and did she raise the roof! She always blames me if anything happens to the car—and you ought to see what *she* does to it!"

Gus bent over to examine the wiring so he wouldn't have to answer that one.

"Short in the relay," he diagnosed after a moment. "If the owner of a '39 bus hasn't anything worse than that to worry about, he ought to be a happy man."

Paul grunted. "As a matter of fact, there is something else. The engine's begun making a queer sort of noise—it sounds as if there's something wrong with a bearing. I noticed it driving up to Round Lake this morning. It kept getting louder and louder, especially when I went over 40."

"There's a one-man garage at the boat landing, and I told the man there to take a look at the engine while I was fishing. The

bass wouldn't bite, so after an hour I decided to drive over to Clear Pond. Back at the landing the garageman told me the trouble was that the oil was too thin. It sounded reasonable because I was still using winter oil, so I had him drain the crankcase and put in No. 30."

"Did that help any?" Gus queried.

"For a while it seemed to," Paul went on. "But before I got to Clear Pond the noise was back as loud as ever. I parked the car and fished for a couple of hours, but I couldn't get a single strike, so I thought I'd call it a day. On the way back the engine ran quietly for a few miles and then it started making the same racket.

"At the Coatsville Garage the mechanic told me that the trouble was in the connecting-rod bearings. He said I could make it home all right if I went slow. I kept under 35 all the way and didn't have any trouble, though the noise was there all the time. It must be made by a bearing that's quiet when the oil is cool and thick, but gets noisy when the oil thins out."

He started the engine. Gus's trained ear immediately picked up the sound, a regular thudding knock that speeded up as Paul opened the throttle. After a moment he signaled Paul to cut the switch.

"It could be a con-rod bearing, and it could be something else," Gus mused. "Anything I told you now would be just a guess. Suppose you let me do a job of checking and we'll know for sure."

Paul looked at his watch. "I've got to get home now," he said. "Agatha has to use the car tonight, and she'll be madder than a wet cat that I'm this late. How'd it be if I bring it in before work tomorrow so you can give it a good going over?"

"Make it day after tomorrow," Gus amended. "Tomorrow I'm going fishing."

"They won't bite," Paul predicted glumly.

THE NEXT day, with Gus fishing and Joe Clark busy in the office, Stan Hicks was feeling comfortably important when a blonde young woman brought a convertible to a rubbery stop at the gas pump. "Fill it up with petrol," she directed in clipped accents. "Huh?" Stan demanded.

"I said," the young woman repeated, "fill it up with pet—I mean, gasoline."

"I getcha," said Stan. "Switch the engine off, please—no, wait a moment." He listened intently. "Hear that noise?"

She listened. "I do rather hear a thump,"

she admitted. "Where does it come from?"

Stan raised the hood, looked as wise as he could, and listened again. "Loose connecting-rod bearings," he announced.

"Oh, bother!" said the young woman.

"You better have it fixed right away," Stan told her. "Otherwise your crankshaft might be scored, and then you *would* be in trouble."

"Bother!" she repeated. "It must have happened since I took Paul down to the bank this morning. If there'd been a thump then he would have noticed it—he's such a fuss!" Her pretty face hardened. "Now he'll say I've ruined his blawsted motor car! How long will it take to tighten those things?"

"Can't tighten them—have to put in new bearings." Stan hesitated because it was really too big a job for him to tackle alone. Then he yielded to the temptation to show Gus how good he was. "I'll have it done by four o'clock," he promised.

"Cheers!" she said, and climbed out.

In the next few hours Stan hung up a new personal record for sustained effort. At quarter to four, when he had the oil pan back on, Gus Wilson drove into the shop. The bass hadn't bitten and he had quit in disgust. "What's all this?" he asked Stan as he eyed the discarded bearing shells.

Stan tried hard to be nonchalant. "Con-rod bearing job for Mrs. Tarlin," he said. "I was just going to road-test her car."

Gus looked surprised. "You mean Mr. Tarlin, don't you?"

"Nope—Missus."

"Oh," said Gus. "I see. . . I'll go with you." Stan drove the convertible out of the shop and up the highway. It purred as contentedly as a cat that sees the top taken off the cream bottle. After a mile Stan started back. "Keep going," Gus told him.

Stan drove on. After another mile Gus's quick ears picked up a noise from the engine—the same muffled knock that he had listened to the day before. He watched a crimson flush spread from Stan's cheeks to his ears and to the nape of his neck. After a minute, his eyes still on the road, Stan muttered, "Go ahead, boss—say it!"

Gus laughed and gave his deflated assistant a friendly poke in the ribs. "You're not the only mechanic in this car who's made a good job of fixing the wrong thing," he said. "Let's get back to the shop."

When they got there, Agatha Tarlin was waiting. "Is my motor car all right now?"

Stan, in the throes of another hot flash,

muttered unintelligibly. Gus went to his rescue. "I'm afraid it isn't," he said. "You see, that noise that Paul noticed yesterday—"

Agatha's lips tightened and her blue eyes flashed. "Oh," she interrupted grimly, "so Paul did something to the car yesterday, and didn't say anything about it so he could blame it on me! That was simply caddish! And I'm going right over to the bank to tell him so!"

"Well, now," Gus mollified, "I wouldn't—" But Agatha was already out the door.

Gus shrugged helplessly. Then he got a steel rod, placed one end of it on the cylinder head, and put his ear against the fist holding the other end. The engine was still running, and with his improvised listening rod he could hear the knock better. "It might be the wrist pins," he said, "but it sounds more like—Stan! Help me get this cylinder head off!"

THEY were ready to lift the head-free when the shop's quiet was shattered by the sound of high-voiced contention. Paul and Agatha arrived together, both talking at the same time. "What do you mean, it isn't my car—just lend-lease?" she shrielled. "I've listened to just about enough such talk, Paul Tarlin!"

By then Stan was carrying the head to the workbench. Gus took one look at the pistons, and quelled the riot by pounding on an oil can with a wrench. "If you kids will quiet down for a moment, I'll show you that you're scrapping about nothing at all," he announced. He pointed to the exposed pistons. "The normal clearance between the pistons and the head on this engine is about an eighth of an inch. See how the carbon has built up on these pistons until it practically

fills the clearance space? Look at these flat spots—that's where the carbon has been hitting the head and making the noise that started all the trouble.

"As soon as we get the carbon scraped off, the engine will run as smoothly as ever. Neither of you is to blame for this—it's just the result of easy-carbonizing wartime gasoline."

Paul looked at Agatha, but she wouldn't look at him. "That's extraordinarily interesting," she told Gus coldly. "Nevertheless, the beastly car must have been thumping when I drove Paul downtown this morning. Knowing that I can't tell if it makes odd sounds, he didn't say anything about it so he could say later that I was to blame!"

Gus grinned. "The engine wasn't making that noise when you started out this morning. You see, when it's cool the pistons and rods contract sufficiently to clear the head. So there isn't any noise until the car has been driven a few miles."

Now Agatha looked at Paul, and after a moment they both laughed. "I say, Mr. Wilson," she said with a grin, "it rawther looks as if I'd been the fuss this time, doesn't it? I'm most dreadfully sorry."

"Skip it," said Gus cheerfully. "If an Englishwoman driving in this country can keep on the righthand side of the road, she's doing well." Agatha made him a graceful mock curtsy.

"And as for the new bearings Stan put in," Gus went on, "your old ones don't seem to have been in bad shape. So you'll have a new set free, and Stan here will have learned not to jump at conclusions. Something which," he finished with a twinkle as Agatha took Paul's arm, "seems to have caught on generally."





MECHANICS AND **HANDICRAFT**

- Highballing on Live Steam
- Paper Control-Line Plane
- Briefcase Radio
- Installing Mortise Locks
- Spontaneous Combustion



Dry-Cell Lamp Goes Anywhere

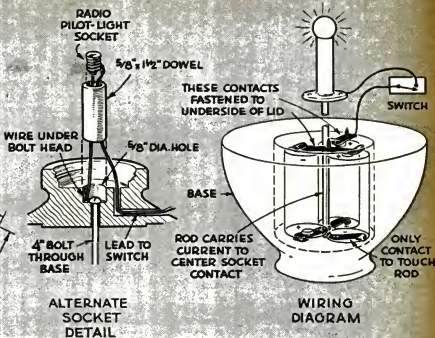
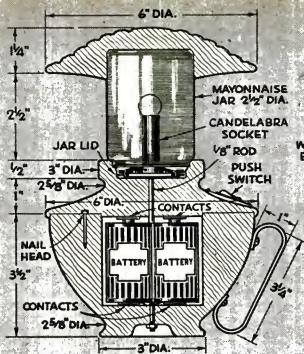
By JACK MELLINGER

FLASHLIGHTS have uncounted uses, but even their most enthusiastic admirers have never suggested that they make attractive table fixtures. This colorful lamp is essentially an unfocused flashlight, but it also deserves a prominent place in your home. Because it will be left out in the open, it will be easier to find and use than the ordinary light that is hidden in a drawer or hung under the back steps.

Since all the wood parts will be painted—in contrasting or matching colors—any soft wood can be used. If necessary, small pieces can be glued up to size. The shape and dimensions given in the drawings are guides; they are not critical and can be altered to

suit your material or your taste. Turn the wood parts first, starting with the cover. In the top of the cover bore a hole large and deep enough to conceal the cap of a mayonnaise or similar jar. The jar itself, when screwed into the cap, will become the globe. Make the lid or shade next, and cut a hole that will fit snugly over the other end of the glass. Turn the outside of the base; then bore out a compartment large enough for three flashlight cells.

For the light itself, use a miniature socket and a three-cell bulb. Solder a long bolt or a rod, threaded at the other end, to the bottom of the socket. Alternatively, you can use a radio pilot-light socket set in a piece of dowel as shown. Drill a hole in the metal jar lid large enough to assure am-



One end of the glass jar is cemented to the wooden shade; the other end screws into the metal lid which is fastened into a recess in the cover.



Open view of the lamp. Note the copper contacts in the cover. These must touch the cells and the center rod as shown in the drawing above.

ple clearance for the rod or bolt. Affix the jar lid and socket with wood screws.

A switch taken from an old metal flashlight is ideal; it is flat, inconspicuous, and has a hold and a lock position. Leaving a narrow flange of metal around the switch makes it possible to attach it to the cover with two wood screws.

The three batteries must be connected in series, which means that two will face in one direction and the third in another. Thin strips of spring brass are screwed down to the wood and bent up to make good electrical contact with the ends of the cells. Solder on fairly fine wire leads to the switch and socket, running them through small, inconspicuous drilled holes.

Once the batteries have been put in

place, it is necessary to secure the parts against any movement that will change or interrupt the contact. If the cells fit too loosely in their compartment, wrap them with tape or paper to provide a friction hold on the walls of the compartment. Then, to prevent misalignment of the cover and base, drive a small finishing nail into the base, allowing the head to project slightly. A corresponding hole in the cover will fit over this projecting stud and keep the two parts in the same relative positions regardless of movement or handling of the lamp.

The handle can be made out of a strip of flat brass, a curtain rod, or any similar metal bent to shape and screwed to the base. Attach the top of the jar to the shade with colorless cellulose cement.



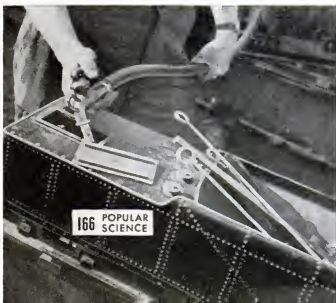
How to Fire Up a LIVE STEAMER

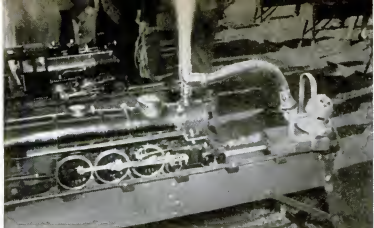
A LIVE-STEAM model locomotive, king of home shop projects, is essentially several hundred pounds of steel and bronze, accurately scaled and painstakingly engineered. Construction time is often several thousand hours. With boiler pressures of 100 lb. or more, it will easily draw six or

eight adults. Such an engine is usually coal-fired and has the familiar coal-smoke-and-hot-oil smell and the familiar (if slightly soprano) *chuff-chuff* of its big brothers. These pictures, taken at a meet of the New England Live Steamers, show steps in preparing for a run on the $3\frac{1}{2}$ "-gauge track.

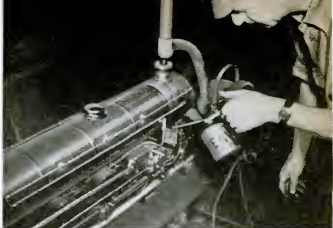
1 The water tank at the back of the tender is filled. Boiler-water level is checked on the glass; if low, a few strokes of the hand feed-water pump quickly bring it up.

2 A few spoon-size scoops of kerosene-soaked coal are now shoveled into the firebox and lighted by a match. The tiny fire door is left open at first to improve the draft. More pea-size anthracite is added as the fire catches hold.





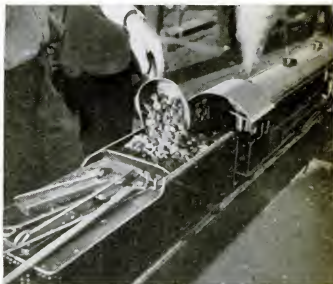
3 A starting blower, consisting of an old vacuum-cleaner motor and jet tube, is connected to the stock to draw air through the fire and get up steam faster. During runs, exhaust steam shooting up the stock performs the same job.



4 While steam pressure builds up, some moments are spent in filling the lubricator and applying oil to the crosshead, valve gear, and the main driver bearings.



5 With the needle on the gauge climbing up toward 80 lb., and with ample water showing on the glass, the little engine is almost ready to roll. The horizontal lever above the fire door is the throttle; reverse gear is on the right.



6 By now the boiler has reached full working pressure; notice the plume of steam from the pop valve. The auxiliary blower is taken off and coal is added to the tender.

7 After a touch of the throttle has moved the engine forward to a sliding section of track, the engineer-builder, Norman Robinson, of Celeron, N. Y., rolls the track to join the main line. His next step is to couple on a flat car.



8 Seated precariously on the flat car, he cracks the throttle and chuffs off. Here he is highballing around a curve at perhaps 15 m.p.h., much faster than top scale speed.



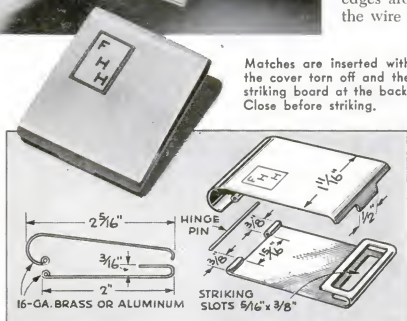


Match-Book Case for Smoker Is All-Metal Craft Project

BRASS, aluminum, dural, or hard copper works up nicely into a pocket case for book matches, an accessory any smoker will be glad to have.

Use 16-gauge metal and cut blanks a little long for the cover and back. Shape the hinge ends first by filing; then hammer the edges around a length of thin wire. Insert the wire as a hinge pin. The big curve of the cover can be formed around a $\frac{3}{8}$ " dowel or rod. Bend the projection at the end as a clip to snap the case closed. Drill striking slots through with a wood strip between, and file smooth. If you prefer only one slot, in the back, cut it before bending.

Either a hammered or polished finish is pleasing, but aluminum can be frosted in a lye solution and brass may be plated. Spot-polishing and wire-brush satin finishes are possible if they are put on before bending. Initials are engraved or enameled.—HENRY HANSCOM.

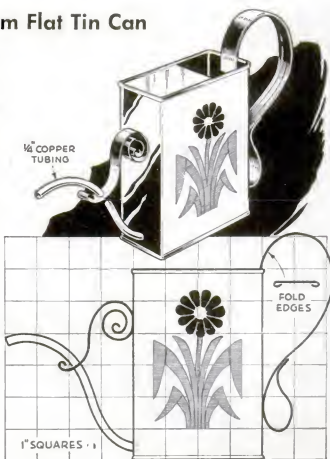


Indoor-Garden Watering Pot from Flat Tin Can

A FLAT pint can—the kind floor wax and solvents come in—can be converted into an attractive watering pot. Begin by carefully cutting out about half of the top, including the screw-cap opening. If the remaining edge is sharp, bend it under to form a safe, smooth edge. Then wash out the inside thoroughly with hot water.

Near the bottom of the can punch a $\frac{1}{8}$ " hole and solder in a 6" length of copper tubing (old automobile gas line will do). Make the spout retainer and handle of tin plate cut from another can. Fold over the two long edges of a 1 1/2" by 14" strip for the handle and shape it over a pattern drawn on 1" squares. Solder it inside the top opening and to the body of the can.

Fold both edges of a $\frac{3}{8}$ " by 8 1/2" strip for the spout retainer, punch a $\frac{1}{8}$ " hole in one end, and solder to the front of the can and to the spout. The inside of the can may be coated with spar varnish or asphaltum to prevent rusting, and the outside finished with enamel and a decal.



River Pilots Race in New Table Game

By HI SIBLEY



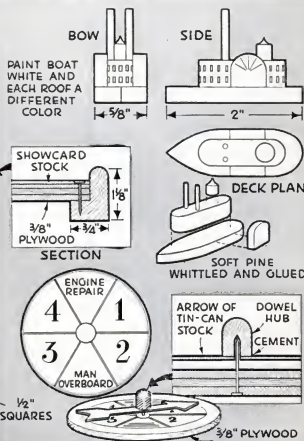
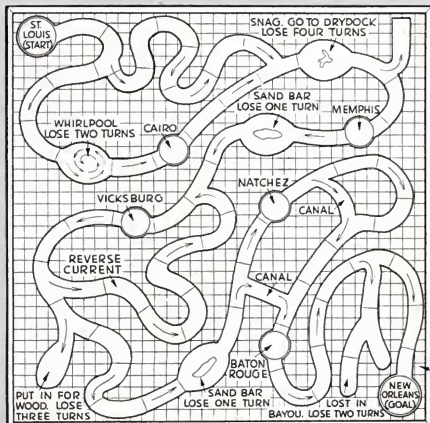
THRILLS reminiscent of the river-boat races of Mark Twain's day are provided by this spinning game. From two to four may play; more may crowd traffic in the "Mississippi" channels. Make a steamboat counter for each player and paint all counters the same except for distinguishing roofs. The board is painted on 18" by 18" showcard stock in contrasting colors, such as green land, yellow water, and red cities. Poster colors will do if coated with clear varnish or shellac.

Players each get one spin in turn unless penalized, as directed on the board, when their counters stop on obstacles. They also lose one turn for loading and unloading if

they stop at cities. When the arrow comes to rest at "Engine Repair" or "Man Overboard," the player loses that move.

The full number of spaces called for in the spin must be taken unless the last space is occupied by a rival, in which case the counter stops one space behind. When a counter is stopped at the entrance to alternative routes, it proceeds on that indicated by an arrow when the next turn comes. It can go into the bayou before "New Orleans" and back out again without loss unless it is stopped in the longer branch.

CITIES RED, RIVER YELLOW, AND LAND GREEN





For flowers or rock plants, the bowl can be fitted with a glass container. The veneer is put on as a ribbon joined to give a spiral effect.

Bowl Veneered in Two Tones

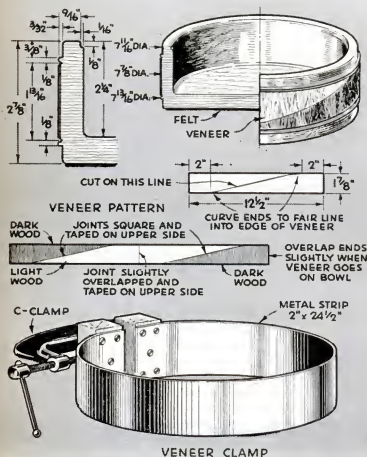
CONTRASTING veneers glued around this bowl in a spiral pattern made it a striking tablepiece. The bowl is turned from a 3" by 8" maple or birch block, and the veneer is cut from two 1 7/8" by 12 1/2" strips, one dark wood and the other light.

On one veneer strip, run a diagonal from a point 2" from one end to another 2" from the opposite end, curving the ends of the line to fair them into the edges. Cut with a sharp-pointed knife. Then use one of the halves as a template for cutting the other strip so the joints will be true.

In turning the bowl, first surface one face and scribe on it an 8" circle, marking the center with a nail set. Then saw roughly to shape to reduce turning time. Rather than mar the bottom with screw holes, bandsaw a disk from 1" lumber, bore a small hole in the center, and glue it to the turning block with paper in the joint.

Rough-turn the piece at the lowest lathe speed, cutting in from the face with the point of a skew chisel to reduce chipping. Then face off the block, rough the inside, and scrape a recess for the veneer.

Now, leaving the work in the lathe, join the veneer pieces in a ribbon with veneer



Half of one veneer strip is used as a template in cutting the other to assure trueness of the joint.



tape or strong paper reinforced with cloth, letting the square ends overlap slightly. Apply waterproof plastic glue to the veneer to within about 1" of each side of the square joints and to the corresponding area of the bowl recess. Pad the veneer with cardboard and clamp it to the bowl. When the glue has dried, trim and fit the loose ends and sand them down.

Then complete the turning, trimming the edge of the veneer first with the point of a skew chisel. True the surface of the veneer, if necessary, with light scraping cuts, and sand all over.

Before applying filler to the dark veneer, protect the light wood with shellac, or with clear lacquer if a lacquer finish is intended.

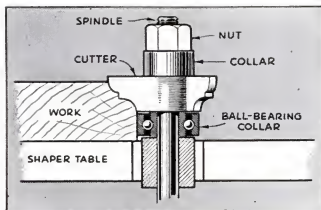


In finishing the bowl inside, projection of the tool rest into the hollow shortens tool overhang.

Scribed Abrasive Sheet Is Easily Torn to Fit Sanding Disk

WHEN cutting garnet paper to shape for a power sanding disk, don't dull your scissors or tin snips. Simply lay the paper face down, place the metal disk on top, and scribe

around it with a sharp point. A sharpened nail or an ordinary scriber will serve. The paper can then be torn easily along the scribed line.



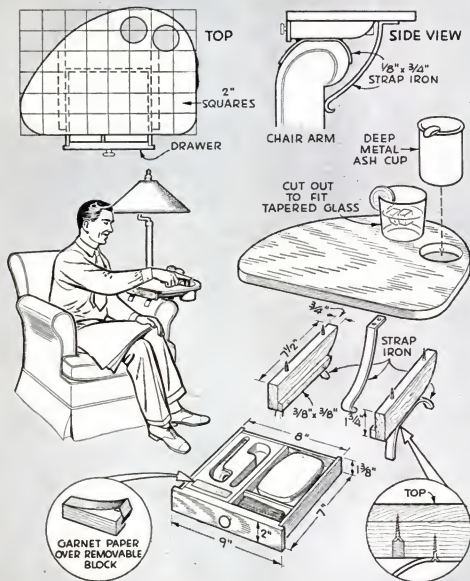
Ball-Bearing Collar for Shaper

IF A cutter is to be raised above the table of a small shaper, a ball bearing of the grease-packed, preloaded type will make an excellent free collar. Its outer race idles when curved work is run against it and thus prevents friction burns. The inside diameter should be slightly larger than the spindle. Such bearings can be obtained in sizes to fit loosely over spindles of $\frac{1}{2}$ ", $\frac{3}{8}$ ", and $\frac{1}{4}$ " diameter.—CHARLES LINCOLN, JR.

Wide Brush Made of Three Push Brooms Smooths Tennis Court

DRAWN over a tennis court before wetting and rolling, a stiff brush will distribute loose clay evenly. A wide brush made by joining three push brooms with a strip of wood screwed across the tops will cut down the work considerably. The handle of the center broom is taken from its socket and fastened across the outer ones for a crossbar.—H. K. FITTS.





Nontip Chair Tray Won't Spill Ashes, Drinks, or Tobacco

BOTH the housewife and her pipe-smoking husband ought to welcome this arm-chair smoking set, because it can't tip over and it has a securely held ash cup big enough to hold all the burnt matches and ashes likely to accumulate in an evening. Pipes, tobacco pouch, or cigarettes are stored in the little drawer; a strip of emery cloth discourages the use of polished surfaces for striking matches.

Walnut or mahogany will make a handsome top. Whatever wood you select, it should blend with the color of your room or furniture. Holes are cut out to hold a tapered glass and a deep metal ash cup. Wooden cleats on the underside support drawer rails and also the strap-iron brackets that curve over the chair arm. Paint the iron to match the chair on which the set is to be used.

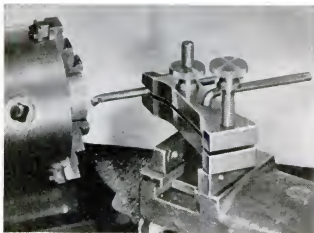
Tools Carried in Glass Case

HAVING daily need for small tools, I use an ordinary spectacle case as a pocket kit for carrying such essential equipment as a neon test light, wrench, screwdrivers, and tweezers.—KARL J. GREIF, Jr.



Removable Cover for Glue Jar

NEXT time you have to loosen the cap of a glue jar or can with a wrench, throw it away and seal the container with strips of cellulose tape, which can be removed in a jiffy.—WILL THOMAS.



UNIVERSAL WORK HOLDER. A new work holder produced by the Wright Mfg. Co., of Elgin, Ill., lies flat on any surface (as at right). Among its many uses in industry and the home workshop are as a bench vise, parallel clamp, and as a lathe tool holder (above). Large thumbscrews permit quick, easy adjustment. The holders sell for \$4.75 each or \$9 in pairs.



AUGER-BIT SET. For faster wood boring, Bruno Tools, of Beverly Hills, Calif., now offers auger-bit sets consisting of one $8\frac{1}{4}$ " shank with interchangeable heads. This makes it possible to bore holes of many sizes simply by changing the head. One set has six heads ranging from $\frac{3}{8}$ " to $1\frac{1}{4}$ " by eighths. Another covers the same range by sixteenths.

NEW GRINDER. An electric grinder announced by the Du-more Company, of Racine, Wis., is a dual-purpose tool for use either as a hand grinder or with an attachment that converts it to a flexible-shaft tool. Other attachments adapt the grinder to bench and lathe-mounted operations. It is powered by a 1/14-hp. motor.



PUMPLESS BLOWTORCH. Generating its own pressure when heat vaporizes gasoline in the tank, this small blowtorch operates without the pump normally associated with such torches. Light in weight and economical to use, it is produced by the National Pumpless Blowtorch Company, Cleveland.



KEEPING the HOME SHIPSHAPE



CLOTHESPIN
HOLDER WITH
MESH-WIRE
BOTTOM

Clothespins won't get dirty from collected dust and rainwater, and soil clean laundry, if the bottom is removed from the box in which they are kept and a piece of galvanized $\frac{1}{4}$ " wire mesh put in its place.

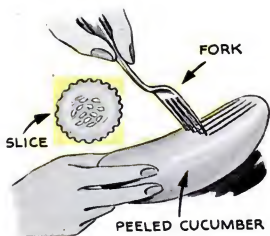
Buttons can be replaced the minute they're missed—at the ironing board—if an assortment is strung on a large safety pin stuck into a pincushion hung in the ironing-board recess. Keep needles in the pincushion, too, and spools of thread on finishing noils.



IRONING-BOARD
CABINET

NAILS TO
HOLD
SPOOLS

PIN CUSHION



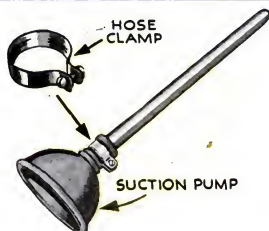
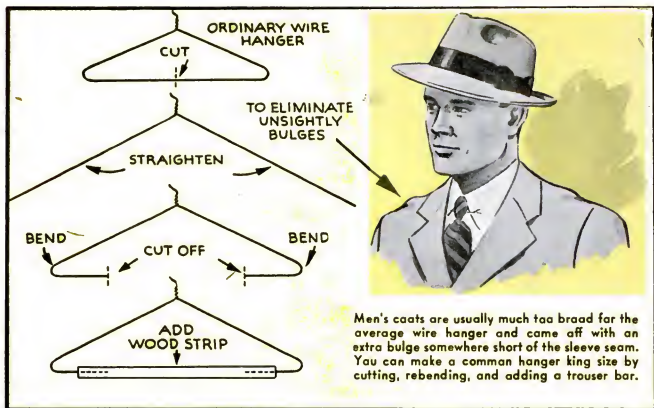
Scalloped edges on thin cucumber slices help make an attractive dish. The scalloping is easy; just run the tines of a fork lengthwise over the peeled cucumber, and then slice.



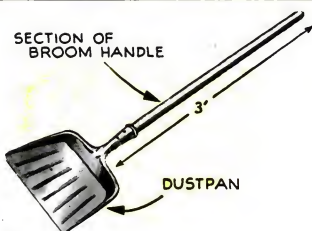
Feathers can be stuffed into a pillow quickly and neatly with the help of a vacuum cleaner. Substitute the tick for the cleaner bag, dump the feathers on a paper, and draw them in.

More comfort for the goldfish and less danger of fire result if you put aquatic plants in the fish bowl. Because of the burning-glass effect, bowls shouldn't be left in sunny spots.



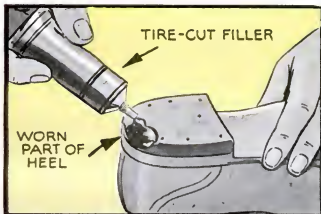


If a suction-pump cup won't stay on the end of a handle, an effective anchor can be made from an ordinary hose clamp, a radio-ground clamp, or a length of strap metal drilled and bolted.



Admittedly not as good looking as the shovel of a brass fireplace set, a dustpan with its wide scoop nevertheless makes short work of removing fireplace ashes. It is easily fitted with a handle.

Run-down rubber heels, cuts, and other worn spots on shoes can be built up at home with a tube of rubber-base tire-cut filler. This is self-adhesive and self-vulcanizing, and it dries overnight.



When a quantity of gummed labels must be affixed and no moistener is at hand, moisten them on an electric-light bulb in a bowl of water. The bulb rotates at a touch and is thus kept wet.

Installing



With the height of the knob spindle gouged 3' above the finish floor, the lock is held against the stile, and the key and spindle holes are scribed. The selvage is held flush or 1/16" in from the edge.

By **EDWIN M. LOVE**

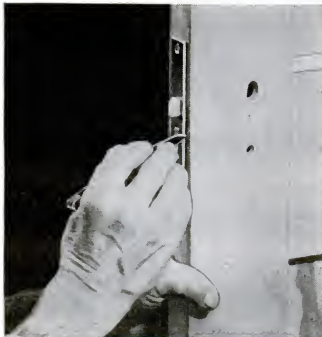
MORTISE locks are most practical for inside doors but are also used extensively as auxiliary locks on outside doors. They are inexpensive, are easy to install, and serve as latches when locking with a key is not required. The mortises to receive them need not be cut any too neatly, and if the key and spindle holes aren't perfect,

before replacing it. Be sure to slip the bolt spring over the prong in the slot when putting it back.

When preparing to install the lock, hold the door open with a pair of wedges driven under the lock stile. Mark the height of the knob spindle—customarily 3' above the finish floor—and, holding the lock against the door with the latch plate or "selvage" flush with the edge, scribe through the key and

scribing for the selvage mortise. Holes are first bored for the spindle and key, and then the lock mortise is bored and chiseled out. If one end of the selvage sinks too far, put a shim under it.

Here the jamb is scribed to width for the strike. Its position is found by closing the door until the latch touches and marking above and below it. Center the striking lip between these marks.



MORTISE DOOR LOCKS

spindle hole to locate their centers. Draw a line also along the top of the lock to guide in laying out the mortise. Some carpenters prefer to set the face of the selvage 1/16" behind the edge of the lock stile to permit dressing down without removing the lock if the door swells and binds.

Next, bore the spindle hole with a 3/8" bit and the keyhole with a 1/2" bit, stopping when the point pricks the opposite side of the door. Finish boring from the other side to avoid splintering. Then elongate the keyhole on both sides with a 3/16" or 1/4" chisel.

Lay out for the mortise by squaring across the edge of the door from the top line drawn on the side of the stile. Draw a bottom line also, and gauge a center line. Bore 3/4" holes 1 1/4" apart and overlap with holes between them. Put the end ones beyond the end lines to clear out the corners and save time in chiseling. Sight along both sides of the door when boring to assure alignment. Regulate depth with a bit gauge or a chalk mark on the bit.

Trim the sides of the mortise with a wide chisel, trying

the lock from time to time until it enters properly. Then punch screw holes with a nail set and screw the selvage to the edge of the door. Scribe around the selvage with a knife point, remove the lock, and mortise the edge to take the selvage, making cross cuts as in dapping for a hinge and trimming to the outline after removing the waste.

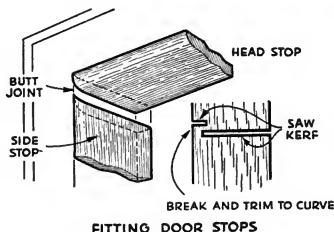
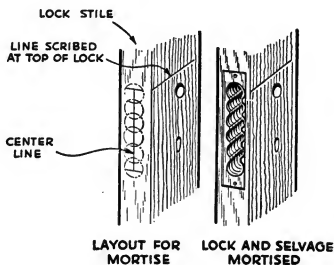
Screw the lock back in place, and if one end of the selvage sinks too far, shim with cardboard or sandpaper. Insert the spindle and try the lock with the knob and key.

Locate the position of the strike, also known as the keeper, on the door jamb by



Mortise locks are always assembled for right-hand doors. Should the flat port of the latch be toward the jamb, take the cover off and turn the latch bolt over. Be sure to slip the spring over the prong.

Screw the strike in place in the jamb mortise, and then cut through the openings with a chisel for the latch and bolt mortises. No great care is required. The only thing that needs watching is to get the recesses deep enough so the latch and bolt will not bind.



Since the rear edge of the head stop is rounded, the corner of the side stop must be shaped to fit in order to avoid showing a gap. The corner is also cut at an angle to simulate a miter.

closing the door until the latch touches and marking above and below the latch. Open the door, hold the strike against the jamb with the striking lip centered on the gauge marks, and scribe for both the top and bottom. Set a gauge by comparison with the lock selvage and score the sides for a mortise. Cut with a chisel in the same way the edge of the door was mortised for the lock selvage, screw the strike on, and with it in place mortise for the latch and bolt by chiseling through the two openings.

Many carpenters wait until after the lock has been installed to set the door stops in the jamb. The stops can then be adjusted to fit the door closely even if it has become somewhat twisted.

Cut the upper stop first to fit between the wide jambs and nail it in place parallel to the edge of the jamb at a distance $1/16''$ more than the thickness of the door. Butt the side stops against the head stop, cutting them a little long so they can be sprung into place and forced into a tight joint. Nail in the hinge stop with a clearance of $1/16''$ against the door hinge stile.

If the door is sprung and is hung, as it should be, with the upper lock corner projecting into the opening, latch the door, force the corner out, and hold it with the stop.

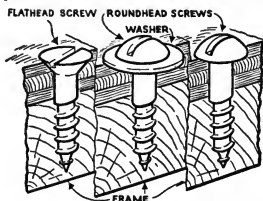
Screw the escutcheon plates on, and then remove them again before painting. When replacing, turn the screw slots parallel with the length of the plates.

END

PLYWOOD SCREW FASTENINGS, I

[WOODWORKING]

Maximum strength in screwing plywood to wood frames is obtained when there is proper balance of screw gauge, length, spacing, and margin (distance from the edge to the screw). If too close to the margin, the fastening may fail through shear stresses, or if too small a gauge screw is used, the head may pull through. Obviously, frames should be of such material and size as not to split or be weakened by the screws. Experience indicates flathead screws alone and roundhead screws used with washers are about equal in holding power. Roundhead screws without washers are markedly inferior.



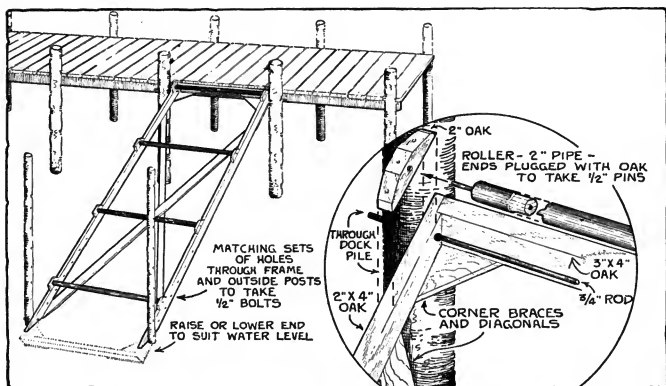
Plywoods may be divided into the following three density groups, each of which has its own screw-holding characteristics:

Low density: Basswood, Spanish cedar, cottonwood, bald cypress, Douglas fir, true fir, hemlock, sugar pine, white pine, yellow poplar, redwood, and Sitka spruce.

Medium density: Black ash, pumpkin ash, white elm, black gum, cotton gum, red gum, hackberry, magnolia, mahogany, soft maple, sycamore, and black walnut.

High density: White ash, beech, birch, black cherry, cork elm, and hard maple.

POPULAR SCIENCE MONTHLY SHOP DATA



Roller Runway Makes It Easier to Launch or Pull Out a Boat

BOATS weighing as much as 400 lb. can be handled with ease on this simple roller-fitted runway. Hinged for quick raising or lowering, according to the water level, it may be installed in the spot best suited to your particular dock or needs.

Provided the outer posts will not interfere with water traffic, locating it at the end of the dock will make it possible to haul out a particularly heavy boat with a small winch or tackle. In a boathouse, it could be hinged from the doorway and be made long enough to reach out to the point where the boat will float. Or the runway might be extended from posts on shore if you haul your boat on a trailer or car.

Build the frame of oak or heavy pine, reinforcing the corners with braces and the entire frame with diagonals. Suit the width to the beam of the boat and adjust the length so the incline at the lowest water level will not be more than 30 deg. Hinge the frame loosely to the piles in order that it may be removed in winter.

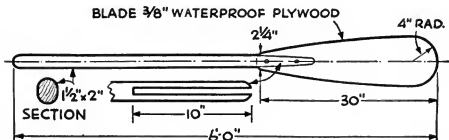
The rollers are 2" pipe cut to length and plugged with 10" or 12" oak dowels to take drive-in pins of $\frac{1}{2}$ " iron rod. Simple oak pillow blocks are used to mount the rollers on the frame every 18" or 24". Matching sets of holes in the outer posts and frame allow for adjustment of the runway to the water level.—J. A. EMMETT.

Waterproof Plywood Provides Blade Material for Pair of Oars

WHY buy a pair of oars when you can make a trim set easily and economically from scrap pieces of $\frac{3}{8}$ " waterproof plywood and two lengths of tough hardwood?

Mark the blade outline on the plywood, saw to shape, round off the edges, sand until smooth, and apply three coats of spar varnish or paint. After cutting the handle to size and slotting the lower end, coat

the slot with resin glue, install the blade, and secure with flathead screws. Paint or varnish to suit.—JOSEPH S. CORLE.



Putting Water to Work

Second of a series on harnessing small brooks and streams. How to measure the available horsepower and pick the right water wheel.

PART TWO

By C. D. BASSETT

MEASURING the flow of water in the stream or brook on your property is the logical first step in planning a small water-power project. The float method of making this measurement, described in last month's installment, is generally the easiest to perform and, if done carefully, is accurate enough for most purposes. If, however, a stream is so shallow at low-water time as

to impede the progress of a weighted float, the weir method of measuring flow has advantages. Essentially a kind of water meter, a weir is a rectangular notch or spillway of carefully controlled proportions located in the center of a small temporary dam. Two simple measurements permit the volume of flow to be accurately calculated.

Before constructing the dam, measure the depth of the stream at the site; the depth of the weir notch, M in Fig. 1, should equal this. Since the dam need not be permanent, simple plank or tongue-and-groove lumber will serve adequately. No water must flow except through the weir, so care should be taken to seal the ends and bottom of the dam by extending planks into the banks and below the bed of the stream. Clay or loam puddling on the upstream side will stop minor seepage. Be sure the

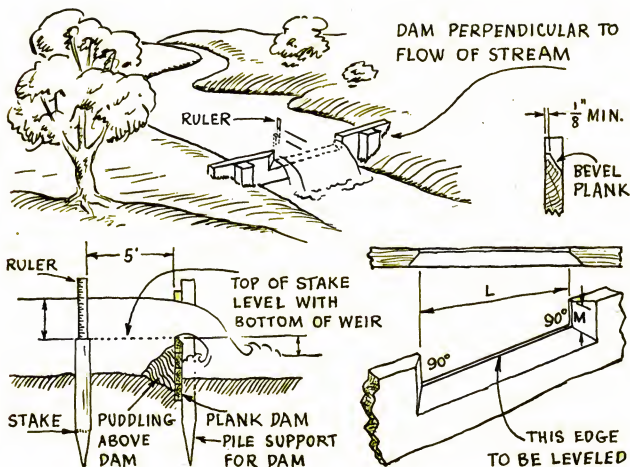


Fig. 1. WEIR METHOD OF MEASURING FLOW. More trouble than the float method, this gives somewhat more accurate results. It is especially useful in shallow streams, or if a dam is already present.

dam is perpendicular to the flow of the stream.

The weir should be located in the center of the dam, with its lower edge not less than 1' above the surface of the water below the dam. This lower edge should be accurately leveled. Both this and the vertical edges of the weir should be beveled with the sharp edge upstream; a $\frac{1}{8}$ " flat on the bevel will keep the edge from breaking down. Proportion the weir so that its length L is not less than 3M, and larger if possible.

Drive a stake in the stream bed at least 5' upstream from the weir, pounding it down until its top is exactly level with the bottom edge of the weir. Allow the stream to reach its maximum flow through the weir and then measure with a ruler the depth in inches of water over the stake. Referring to the table on this page, you can now read the number of cubic feet per min. of water for each inch of L, the weir width. If you multiply the figure from the table by L, the result is the total amount of water flowing in cubic feet per minute, which is Q in the horsepower formula given last month.

If your stream is already dammed, there is no need to construct another dam just to measure flow. It is quite possible to employ the existing dam, using its spillway as a weir, provided that all water can be made to pass through the spillway. Construct a wooden or metal frame to fit the spillway and seal it in place snugly. The center of this frame should incorporate a properly proportioned weir notch. As before, M should equal the depth of the water flowing through the spillway before the weir is installed, and L may in most cases be half the width of the spillway.

To get an accurate estimate of available horsepower, you will need a precise figure for H, the head of water that will be present. Head may be defined as the vertical distance in feet from the surface of water in the pond behind the dam to the surface of the stream below the dam at the site of the wheel. This figure may be obtained by any of several methods in cases where a dam is already present, and with scarcely greater difficulty at the site of an unbuilt dam.

Measuring a difference in elevation can

be quickly and accurately done with an engineer's transit and leveling rod. But since not everyone has access to these instruments, and since those who do would not need instruction on so simple a job as running a level, we'll pass on to other methods.

Figure 2 illustrates a very simple way of measuring a vertical distance. The equipment required is a carpenter's level, a folding rule or steel tape, a 1" by 2" by 6' board with two edges planed parallel, two wooden pegs, a stake, and a C-clamp. These are items that can be found in almost any home, and certainly any farm. Though the method can be somewhat tedious if the difference in elevation is large, the results will be quite accurate with ordinary care in leveling and measuring. Note in

Inches Depth over Stake, D	1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
1 inch	.40	.47	.55	.65	.74	.83	.93
2 "	1.14	1.24	1.36	1.47	1.59	1.71	1.83
3 "	2.09	2.23	2.36	2.50	2.63	2.78	2.92
4 "	3.22	3.37	3.52	3.68	3.83	3.99	4.16
5 "	4.50	4.67	4.84	5.01	5.18	5.36	5.54
6 "	5.90	6.09	6.28	6.47	6.65	6.85	7.05
7 "	7.44	7.64	7.84	8.05	8.25	8.45	8.66
8 "	9.10	9.31	9.52	9.74	9.96	10.18	10.40
9 "	10.86	11.08	11.31	11.54	11.77	12.00	12.23
10 "	12.71	12.95	13.19	13.43	13.67	13.93	14.16
11 "	14.67	14.92	15.18	15.43	15.67	15.96	16.20
12 "	16.73	16.99	17.26	17.52	17.78	18.05	18.32
13 "	18.87	19.14	19.42	19.69	19.97	20.24	20.52
14 "	21.09	21.37	21.65	21.94	22.22	22.51	22.79
15 "	23.38	23.67	23.97	24.26	24.56	24.86	25.16
16 "	25.76	26.06	26.36	26.66	26.97	27.27	27.58
17 "	28.20	28.51	28.82	29.14	29.45	29.76	30.08
18 "	30.70	31.02	31.34	31.66	31.98	32.31	32.63
19 "	33.29	33.61	33.94	34.27	34.60	34.94	35.27
20 "	35.94	36.27	36.60	36.94	37.28	37.62	37.96
21 "	38.65	39.00	39.34	39.69	40.04	40.39	40.73
22 "	41.43	41.78	42.13	42.49	42.84	43.20	43.56
23 "	44.28	44.64	45.00	45.38	45.71	46.08	46.43
24 "	47.18	47.55	47.91	48.28	48.65	49.02	49.39

Table from James Leffel & Co.

This table shows the quantity of water passing over a rectangular weir in cubic feet per minute (cfm) for each inch of notch width. Depth D is read as a combination of the lefthand column and the top row. For example, if the depth over your stake is 5 $\frac{3}{4}$ ", follow over 5 (fifth row) to $\frac{3}{4}$ (fourth column), and read the value as 5.01 cfm. Don't forget that this figure should now be multiplied by the width in inches of your notch.

the drawing that in the case of a pre-existent dam, one or more measurements needed to carry around the edge of the dam are subtracted from rather than added to the total.

Less practical in most cases, though still of occasional special value, are two other ways to determine head. Elevations can be measured quite readily by the techniques of photographic surveying. For those who

are familiar with the procedure, it is a simple matter to take the required pictures in the field and then scale the required elevation at the desk from the developed photographs. Another method involves the use of a barometer, either mercury or aneroid, to indicate differences in height. However, this method is useful only where the head to be measured is considerable, say, more than 25', and calls for special

techniques to hold the probable error down to acceptable proportions. Except in unusual circumstances, the writer recommends that the method in Fig. 2 be employed, inasmuch as it requires little special equipment and with ordinary care gives good results.

With sound figures for both H and Q , you are now ready to calculate the available horsepower of your installation with the formula given in the first installment. If the power is found to be sufficient to warrant continuing with the project, say $\frac{1}{2}$ hp. at the least, your next step is to determine the nature of your power requirements. Here individual variations are so many as to make it difficult to outline a specific procedure. It's possible, however, to suggest factors you should consider in planning your power plant.

Some of the uses to which small-capacity installations are successfully put

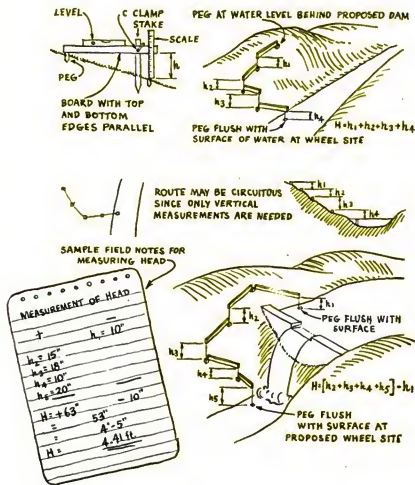
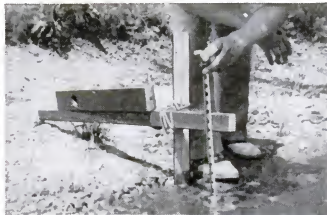


Fig. 2. MEASURING HEAD. With a carpenter's level, straightedge, and pegs, head can be measured before or after the dam is built.



With the straightedge held level, vertical height between a pair of pegs is read off and noted down.



Your last measurement should be to the surface of the water at the site selected for the water wheel.

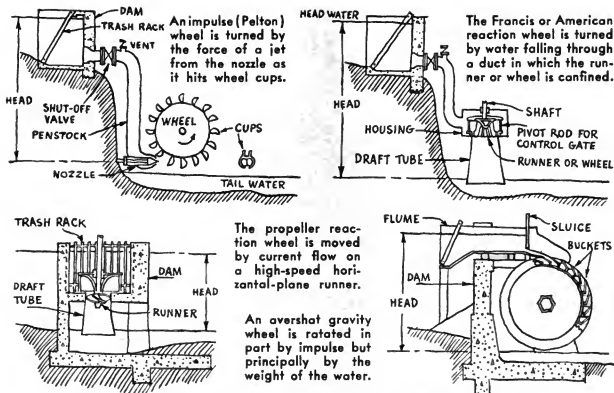


FIG. 3. FOUR TYPES OF SMALL WATER WHEELS

include directly powering pumps, mills, machine tools, or other small-demand machinery; and driving a generator to supply electricity for either lighting or power purposes. The latter type of installation is of course the more flexible and generally useful. Determine, then, the uses you propose for your water power, and tabulate the horsepower required after each item. In the case of electric motors or appliances rated in amperes or watts, remember that watts are volts times amperes, and that 746 watts are equal to 1 hp.

From this tabulation, the peak load can be determined. This is the sum of the power demands made by different pieces of equipment that may probably be in use at one time. Knowing power and load, you can now determine if the proposed installation will be on a sound basis.

Do not use your available horsepower figure directly, since deductions should first be made for losses in the water wheel and in the generator, if one is to be used. For small installations, assume wheel efficiency to be 75 percent; many small wheels will better this, but the assumption will provide leeway for possible optimism in measuring H and Q. Generator efficiency can be assumed to be 80 percent, a figure that will also be bettered in many cases but is on the safe side. Thus switchboard power may

be expressed at $.75 \times .8 \times \text{hp}$, or .6 of the available horsepower.

At this stage of the game, it's well to mull over the possible variations and combinations, rather than to proceed with specific construction plans. Consider for example the decision required if the indicated switchboard power will seemingly handle the peak load—whether to build a dam just large enough to do this job, or to build one substantially larger to handle possible future increases in power requirements. The former choice will be obviously cheaper at first but may not be so in the long run, since power demands have a way of growing and since it is rarely satisfactory to increase the structure of an existing dam.

If the peak load is apparently too high, various possibilities should be considered. Will "pondage"—water stored behind the dam overnight or in slack periods—help out? Can the use of equipment be rationed in some way to level out the load peak? Can some nonessential equipment be dispensed with? Is the project necessarily a year-round enterprise, or can the low-power characteristics of the dry season be ignored? A word of caution on these points may not be amiss: it's far better to plan an installation that will provide more power than you need than one which doesn't supply enough.

Whether, in the event that you decide to

generate electricity, to use AC or DC is another decision to make. In circumstances where the generator must be located some distance from the load, AC is the only choice, for DC transmission losses would be too high, amounting in small installations to a prohibitive percentage of switchboard power. If your buildings and equipment are already wired to receive one type of current, it would obviously be sensible to fix on the same type of power; if for example your farm is already wired for a battery-type lighting system, there would be little reason to revamp the installation for AC. If on the other hand you are starting from scratch, the writer recommends the use of DC wherever possible. An AC generator must be closely regulated at or slightly above synchronous speed, and close regulation requires complicated governing equipment that is tricky to build or expensive to buy. A compound-wound DC generator, on the other hand, provides inherently close voltage regulation over a wide speed range; and even a shunt-wound DC generator with a direct-acting field-rheostat regulator would be satisfactory.

Selecting the right wheel for your plant is perhaps the final step in your preliminary planning. There are three general types of water wheel—impulse, reaction, and gravity—and several fairly common varieties of each type. However, for small plant purposes, it is possible to narrow the number down to those shown in Fig. 3. Note that two types of reaction wheels, the Francis and the propeller, are shown, and but one variety of gravity wheel, the overshot one.

The impulse or Pelton wheel, operated

exclusively by the force of the water from the jet, includes among its advantages very slight leakage and friction losses, good efficiency under varying flows, and a sufficiently high shaft speed to drive a generator. It is more resistant to pitting by water containing sand, silt, or minerals than the reaction type. Its disadvantages include the fact that it cannot use all the available head, is larger than a reaction wheel developing the same power, and will wallow in high tail water. It must be mounted as close to the tail water as possible.

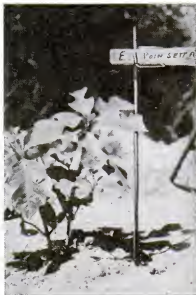
The reaction wheel, either the Francis or propeller type, is turned by the fall of water through a duct or pipe in which the wheel is confined. It is the most compact of all wheels for a given power, uses all of the available head, and operates at a satisfactory speed for direct coupling to a generator. It is an efficient wheel over a wide range of conditions, and it can be mounted at any convenient height above tail water. Disadvantages include rapid corrosion with silted water, and relatively high leakage and friction losses, especially in small units.

Finally, there is the overshot gravity wheel, which is turned largely by the weight of the water and partly by impulse. It has good efficiency under varying flow, and is unaffected by sand, silt, or minerals in the water. Gravity wheels turn at a low speed, which is undesirable for driving a generator or high-speed machinery, but suitable for some pumping and grinding applications. Such a wheel will wallow in high tail water, is the largest wheel for a given power, and will be obstructed by ice in winter unless housed.

TO BE CONTINUED



GARDEN HINTS. A bag to collect the seeds of valuable plants, as at the left, can be readily obtained by cutting a length of coarse mesh stocking, tying one end, and turning it inside out. Placed on the plants a few days before the capsules burst, such bags will greatly increase the production of breeding seeds. Right, a spring clothespin lettered with India ink makes an excellent plant marker. It may be attached to a wire fence, dowel, or stick. Sand the sides if you wish to re-letter it.—TERRELL NICHOLAS.





CHEESE PENTHOUSE. I'm wild about ripe cheeses, but my wife absolutely refuses to give such nutritive scents house room in her kitchen or refrigerator. In desperation, I built a storage case and mounted it outside the kitchen door, placing it high enough to foil any four-legged highjackers. Now I have cheese when I want it, although the breezes on that side of the house sometimes become suspect.—JACQUES TORRE.

KNOTS SUCH A BAD IDEA. One big knot in my new clear-pine kitchen cabinets gave me an idea. Using various sizes of burnt corks touched to some orange shellac, I copied the knot many times, twisting the end of the cork against the wood and imparting a few curves with the edge. Then I applied maple stain. Now I have a fine collection of knots and never have to worry about 'em becoming knotholes.—J. W. CARR.



IQ

WHAT'S YOUR INGENUITY QUOTIENT?

Have you pulled off a smart one lately? We will pay for acceptable contributions showing ingenious solutions of problems in the home, shop, garage, or camp. It doesn't matter if it's wacky — if it works.



TICK STOPPER. I can take the spine-jolting jangle of my alarm, but the night-long ticking wears me down. A glass cover cut from a gallon jug now lets me snooze, keeping ticks in, dust out.—JOHN A. WITTNER.

IT'S MONEY IN THE TANK. At last I've found a way to keep myself from dipping into my savings. After I bought a new car in 1940, I made it a practice to drop a nickel into the gasoline tank for every gallon I bought. Last year I traded in the car. It was rather difficult to get the nickels, but the two bucketfuls were more than enough for the down payment, and there wasn't a bit of sludge in the tank.—THOMAS R. MUHA.



This smooth-flying job is no "hot rock," but monocoque construction makes it a breeze to build.

HERE'S a control-line model that can be counted on to give many hours of troublefree flying, for the method of construction insures a high strength-weight ratio. Covered with stiff paper, it has an all-metal appearance that is easily obtained with two or three coats of dope. A class A engine whips it around at a good rate, though it is not in the "hot rock" speed category, and adequate wing area permits it to land smoothly.

Fashion the 17 $\frac{1}{2}$ " long fuselage backbone or longeron from a piece of $\frac{1}{8}$ " sheet balsa. To this first attach a bulkhead A, which also serves as the firewall, installing two right-angle gussets to obtain good alignment. This bulkhead is $\frac{1}{8}$ " plywood, but all others are cut from medium-hard 1/16" sheet balsa. Bulkheads B, D, E, and F have openings to reduce the weight and allow the control push rod to pass through, but all the lower sections are solid. Because of the rigidity provided by the paper covering, it is unnecessary to notch in the bulkheads. Simply cement them in place.

Cement a $\frac{1}{8}$ " by $\frac{1}{8}$ " balsa brace between bulkheads A and B and two others as cockpit edges from D to each of the C uprights, but leave parts H and the windscreen until after the wing frame has been assembled and attached. The two parts H are canted inward on an upward diagonal from the two C members to B, forming the forward edge of the cockpit.

While the fuselage is drying, build the wing frame. Drill the $\frac{1}{8}$ " by $\frac{3}{8}$ " spar midway to take a 2-56 by 1" screw that serves

Stressed-Paper Control-Line Plane

By ROY L. CLOUGH, JR.

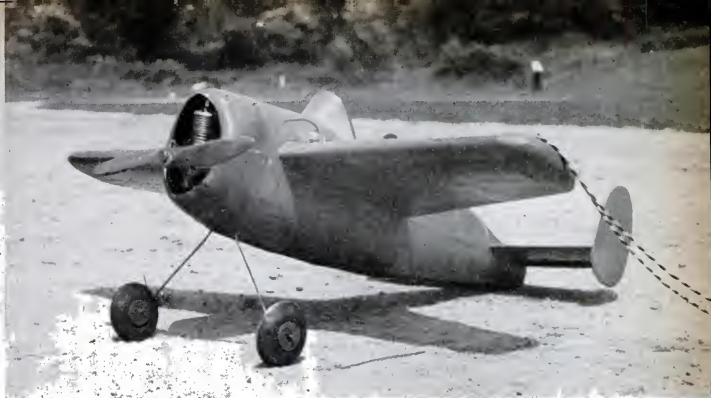
as the pivot of the control plate. Recess the head into the spar and coat the entire screw liberally with cement before pushing into place. Form the landing gear from 3.32" wire. The anchor is a brass washer bent around the wire and soldered to the mounting screw. Bolt the assembly to the firewall.

Known as ledger paper, the stock used to cover the model mikes about .008". It bends easily with the grain and has a smooth finish that takes dope well. Cover the bottom of the fuselage first, starting with the rear-most section and working forward, overlapping each joint. A template is unnecessary. Just cut the paper to approximate size and trim after cementing. In covering the section behind the landing gear, cut notches at least $\frac{3}{8}$ " deep around the wire so landing shocks will not tear the paper. Never attempt to cover more than one section at a time. To do so will cause buckling, cement "dimples," and general unevenness.

After the bottom of the fuselage is covered, install the engine mounts. Then proceed to the tail surfaces and the balsa block that streamlines the tail. Note that this block is shaped to limit elevator down travel to 3 16". For the proper hinge effect, two of the cloth hinges must be installed with the cloth on top of the



Two pen cells in the cockpit are easily accessible, making boosters and an ignition switch unnecessary. Note the engine vent behind the cowl.



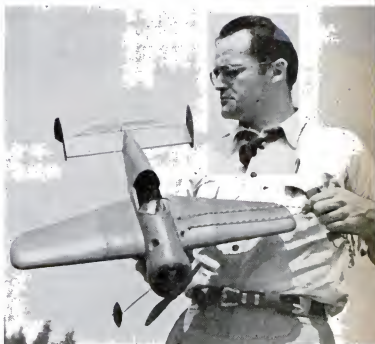
Although shown above with a class A engine, this model could be flown with a class B. At right, "Poppy" Tom Herbert, White Plains, N. Y., holder of the class 5 and 6 speed records, looks over the controls before flight-testing the ship for PSM.

control surface, and two with it below as seen in the circled drawing. When the tail assembly is in place, cement on the two 1/16" by 1/16" covering guides as indicated.

Now cover the upper portion of the fuselage as far forward as bulkhead D. Then put the wing frame in place, using plenty of cement in attaching the main spar to the fuselage frame and bulkhead B. Do not, however, cement the butt ribs, for the paper on this part of the fuselage must be extended behind the ribs.

Next, install the coil, control system, and the wing tank (if the engine requires the latter). Make the tank of sheet acetate or similar plastic, cementing all seams well. The fuel intake line is a short length of 3/32" aluminum tubing, and connection is made to the engine with neoprene tubing. Be sure to put the fuel system in such position that the centrifugal force developed as the model flies will aid rather than hinder the fuel flow. Mount the coil off-center to the right.

One of the secrets of good engine performance is good wiring. In this case, the size commonly employed for high-tension leads is used for all wiring except that leading to and from the condenser. Since coils seldom burn out and because of the simplicity of the wiring, this part of the system may be sealed under the covering. The con-

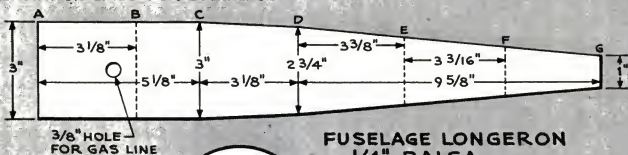


denser, however, should be located under the cowling, for this item gives frequent trouble in any model. (Remember, the condenser is to blame for 90 percent of all starting troubles. If everything else seems okay but the motor does not start, or starts and runs unevenly, change the condenser.)

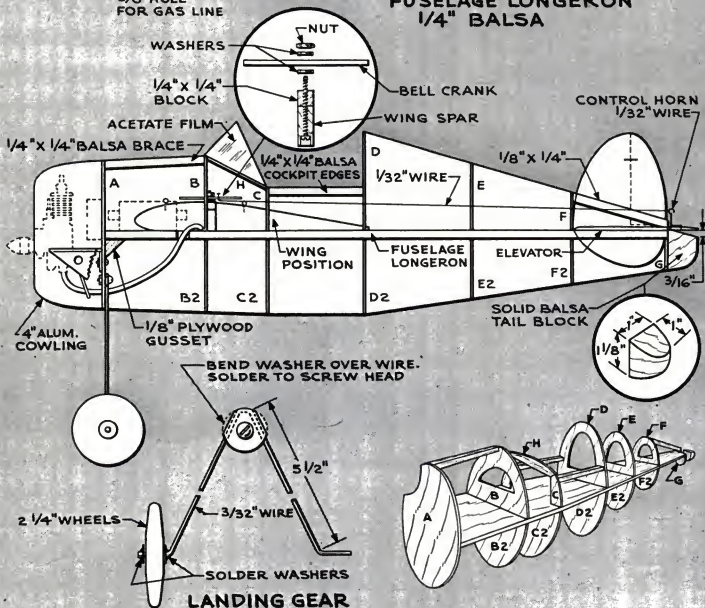
A standard bell-crank control system is used. The plywood crank pivots on the 2-56 by 1" screw run through the wing spar and a 1/4" by 1/4" spacer block mounted atop the spar. Make certain the system does not bind at any point. The lines are thrust through slots in the fuselage and two eyelets on the wing tip.

In covering the wings, start at the tips and work inward. Cut a piece of paper to a bit more than 3" wide, cement one edge

DOTTED LINES & WIDTH DIMENSIONS
ARE STATION LINES FOR BULKHEADS



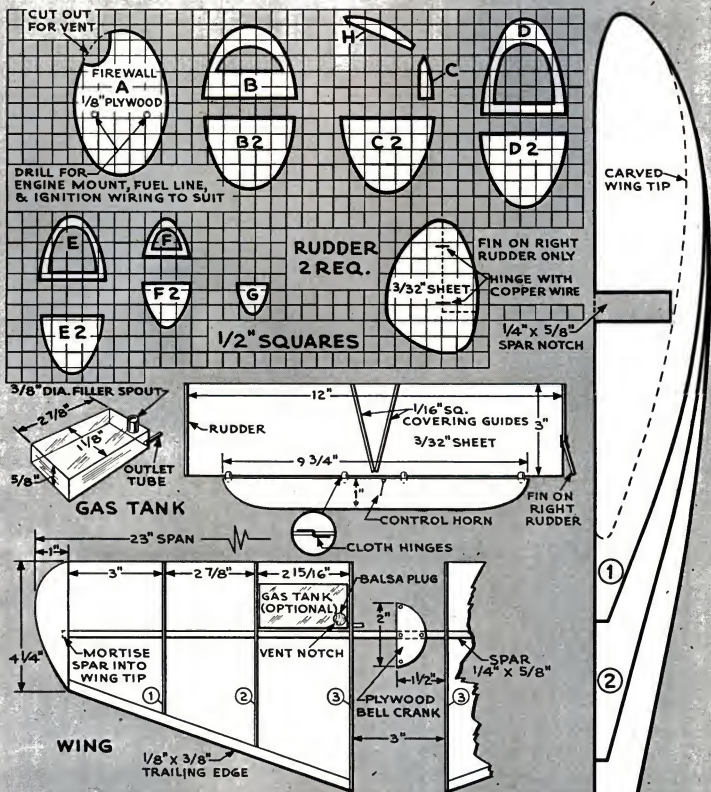
FUSELAGE LONGERON 1/4" Balsa



to the underside of the main spar, draw it up and around the leading edge, across the top of the ribs to the trailing edge, and then trim. A separate piece goes on the under part of the wing behind the spar. Here, as on the fuselage, do not attempt to cover more than one section at a time. When the wings are finished, cover the remaining sections of the fuselage and run a cement fillet around the juncture of wing and fuselage.

Form a 4" aluminum engine cowling to the elliptical cross-section of bulkhead A by gently pressing it, and attach it on either side with a small wood screw or pin. Spark and gas controls should be extended to the cockpit for easy handling. The vent is adequate to insure good cooling, but if your engine runs "wet" it may be a good idea to slot the bottom of the cowling.

For test flights, use a low-pitch prop and



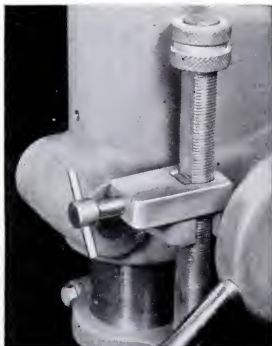
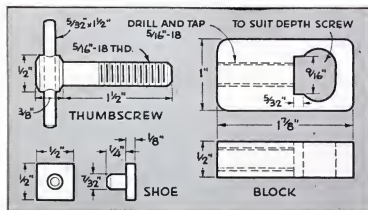
RIBS (1/16" SHEET) SHOWN FULL SIZE

adjust the engine to turn over at a trifle above half throttle. Use full right rudder at first, easing off on this control if there is excessive pull. When the motor stops, dive the ship to within a foot of the ground and apply full-up elevator for a smooth three-point landing.

Because of the exceptional fore-and-aft stability of the model, very little time is required to learn to fly it. END

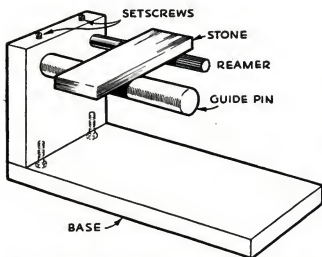
Wing tips carved from balsa also serve as the end ribs. The wing is built without a leading-edge spar and has no dihedral.

NEW SHOP IDEAS



DRILL STOP. Mounted on the depth screw of a drill press, this stop provides a quick way of adjusting the distance of drill travel. A steel thumbscrew projects far enough from the drill press for convenience in adjusting, and a steel shoe with a relatively large sur-

face prevents damage to the face of the depth screw. Make the block from steel, brass, or aluminum alloy, milling or filing the opening for the depth screw after drilling to approximate size, and then form the recess for the shoe.—**JOHN A. BATES.**

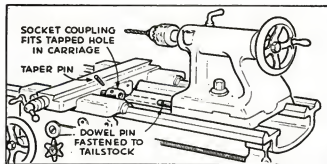


REAMER SHARPENING JIG. When a reamer is to be hand stoned, the guide pin of this fixture will keep the stone constantly at the proper angle to the cutting edge. If the reamer is tapered, make the guide pin with the same taper, instead of straight as above.

Both guide pin and reamer are pinned into the upright block with setscrews. The upright either may be mounted on a base with machine screws or held snugly in a vise. Bushings may be made to accommodate different sizes of reamer shanks. The guide pin is approximately twice the diameter of the reamer.—**EDMUND L. JOHNSON.**

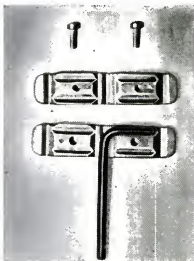
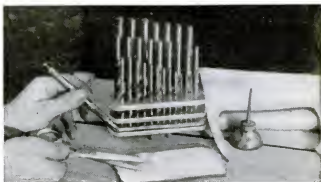
PAPER SHIELDS WORK. Finding that shavings scratched the aluminum I was trying to turn to a smooth finish, I placed a heavy sheet of paper between the tool and the work. The shavings then came through the hole the tool cut, and the paper prevented them from marring the work.—**T. G. LUCAS.**





TAILSTOCK POWER FEED. This coupling provides power feed for drilling, boring, and other operations in which either the tool or work is mounted in the tailstock. Fitted into a hole drilled in the latter, a dowel pin slips into a receptacle mounted on the carriage and a taper pin locks the two. Removing the taper pin restores the lathe to normal operation.—HAROLD KRUER.

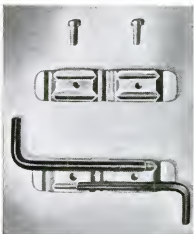
RUG PROTECTS DRILLS. At the time of purchase, the drills in a set usually are placed in their holder with points upward, but it is safer to store them pointing downward. A piece of rug or other thick material cut to shape, cemented on the holder floor, and soaked with oil will protect the points and prevent rust.—ANDREW VENA.



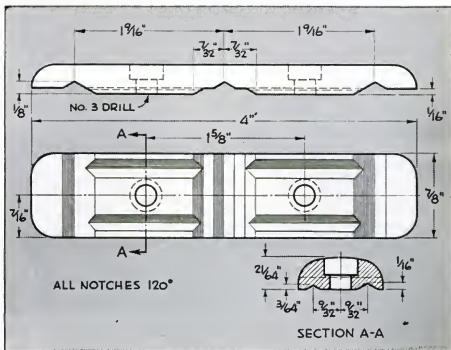
When a job requires use of the long arm of the wrench, mount it as above. These transverse grooves also adapt the handle for use on various other tools.

HANDLE FOR ALLEN WRENCHES. A handle such as this gives a better grip on an Allen wrench and can be quickly shifted from one to another of a different size when necessary. Transverse V-grooves also make it possible to use the handle on a tap, reamer, star drill, file, or other tool.

The wrench was made from a 1" round aluminum bar 4" long sawed in half from end to end. Two parallel grooves then were filed lengthwise on the flat faces about $5/32$ " from either side. One groove in each piece was filed $3/64$ " deep, but the other two were made deeper so two wrenches of different size could be clamped in the handle. To accommodate the curved part of the wrench, flats were filed to a depth of $1/16$ " in the middle and at each end. Both pieces of the handle are alike except that the bolt holes in one are tapped 10-24 and those in the other are drilled No. 3 and counterbored for fillister-head screws.—CLARENCE WITTE.



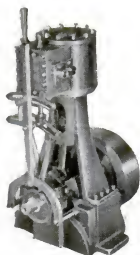
Two wrenches of different size are placed in the same handle.



Machining Cylinder

By C. W. WOODSON

PART TWO



MUCH of the performance of a steam engine depends on the accuracy and smoothness of the cylinder bore. This is as true for the miniature reversing engine here described (see PSM, April '47, p. 190) as for full-size engines.

The casting for the cylinder is first mounted in the the three-jaw chuck and a roughing cut taken across the bottom so it can be reversed and held squarely for facing the top. If you have available an expanding mandrel, the cylinder is best bored after the rough facing and then mounted on the mandrel, where its ends can be faced smooth and squared accurately with the bore.

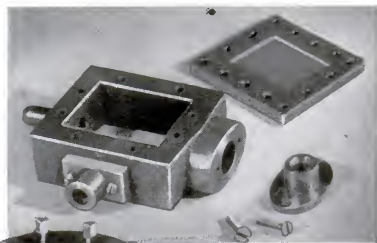
Lacking such a mandrel, face the top smooth first, and then reverse the piece and face the bottom smooth and square before attempting to bore. Although the cylinder may be held in the three- or four-jaw chuck for these operations, there is less likelihood of slipping if it is clamped to the lathe face-plate with lugs over its flange.

Bore the cylinder first with a heavy

roughing cut to get the bit under the hard surface scale and bring the hole nearly to size. Then, with a freshly ground bit inserted in the boring bar, take light finishing cuts while using a very fine power feed. If care is taken in sharpening the bit and setting it to eliminate chatter, an almost mirrorlike finish can be obtained.

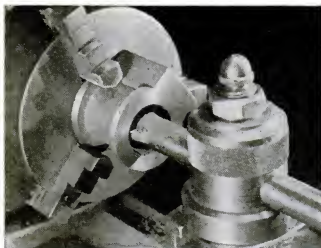
The steam-port face can be machined in the shaper or, as shown in one of the photographs, while mounted on an angle plate in the lathe. Again take a heavy roughing cut first to get under the scale, and then, with the bit freshly ground and honed to a keen edge, finish with light cuts and a fine feed.

Remove the work to the drill press, clamp in the vise, lay out the steam and exhaust ports carefully, and drill a series of holes for each. Chip out the intervening metal and file the resulting slot to shape. Then mount the work in the angle vise and drill four holes for each of the two angle ports to meet those in the face. Chip and file out as before. A chisel made from 3/32" drill rod and hardened may be used for chipping. The cylinder is next remounted in the vise and

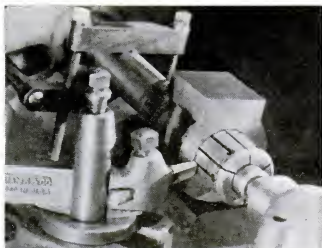


Finished parts for assembling the cylinder of the vertical engine are shown here. Also required are a bottom cover and stuffing-box gland for the piston rod.

MAY 1947 193



1 In boring the cylinder, take a heavy roughing cut to get under the surface scale. Finish the bore with light cuts and a freshly ground bit.



2 If an expanding mandrel is available, bore the cylinder before finish-facing the flanges; if not, machine the flanges first and then bore.



5 Drill and tap one hole in the flange, and then bolt the cylinder head on before spotting the others. Use a clamp at the opposite side.



6 Face the steam chest on both sides, taking a heavy roughing cut on each first and finishing with light cuts to assure a steamtight joint.

the exhaust port drilled in from the side to meet that in the face. Don't drill the 4-48 holes until the covers have been made.

Mount the cylinder-head casting in the three-jaw chuck and turn the chucking lug straight so the casting will run true when reversed. Machine the top and outer edge to shape, and then score a light 1/8" circle on the face for locating the bolt holes. Again reverse the piece in the chuck, take off the chucking lug, face smooth, turn the step to a good snap fit in the cylinder bore, and drill a 7/16" hole 1/4" deep to clear the nut on top of the piston.

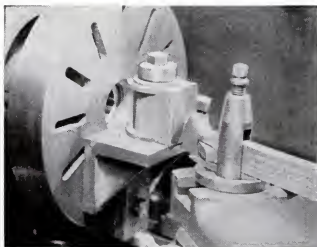
The bolt holes are then stepped off accurately with dividers, centerpunched, and drilled clearance size. Snap the head in place, spot one of the holes in the flange with a clearance-size drill, drill tapping size, and tap. Next, insert the bolt and spot the remaining holes. Make a file mark on meet-

ing edges so that the head can be replaced in the same position; then finish drilling and tapping the flange.

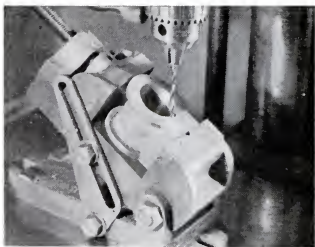
In machining the lower cover, it is important that the step fitting in the cylinder bore be concentric with the piston-rod hole so there will be no binding at that point. Equally important it is to turn the step on the outer face, or bottom, concentric for fitting the shouldered bore in the standard.

One way is to turn the gland stem and shoulder on the outer face first, bore and counterbore the 3/4" hole, and then mount the piece on a stub arbor or in a step chuck to face and step the inner side for a snap fit in the cylinder bore. In counterboring for the gland, be sure to start carefully in the piston-rod hole to assure concentricity.

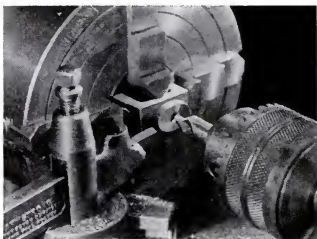
Snap the lower cover on the column, clamp, and spot the bolt holes through the column flange. Then snap the cover on the



3 Machine the steam-part face with the cylinder mounted on an angle plate, finishing with very light cuts. A shaper will also do the job.



4 Parts are bared at an angle from both ends of the cylinder to connect with the steam ports in the face. Chip and file them to shape.



7 Chucked gland end out, the steam chest can be drilled and reamed for the valve stem and the hole then opened out to take the gland.



8 Corner holes are completed first in the steam chest and cylinder steam-part face; then the parts are bolted and the remaining holes drilled.

cylinder and repeat as for the head. Put witness marks on the column, cover, and cylinder flange, making certain that the valve face is at 90 deg. to the crankshaft centerline of the base.

Face the steam-chest casting on both sides, holding it in the four-jaw chuck, and bring it to proper thickness. A heavy roughing cut followed by several light finishing cuts will assure a steamtight joint.

Some difficulty may be encountered in drilling for the valve stem, since the inner surfaces of the steam-chest casting will have a slope. If you have a hand grinder, a small flat can be ground inside the stem-guide end for a drilling surface, after which the steam chest can be chucked and the hole drilled all the way through from the gland end. Otherwise it may be best to lay out the holes as accurately as possible on the outer surfaces, drill each from the outside with

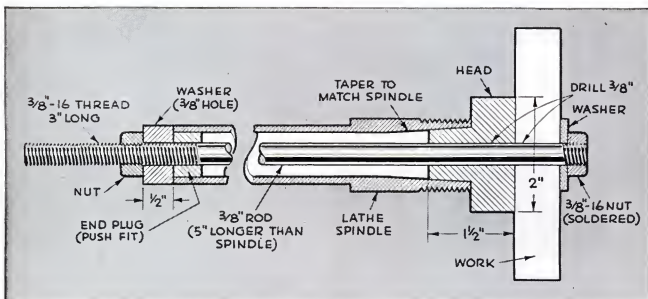
an undersize drill, and then ream from the gland end. In this case, drill the gland end first, counterbore, and support it with the tailstock center when drilling from the stem-guide end. Finish by enlarging the upper hole with a No. 3 drill and tapping $\frac{1}{4}$ "-28.

Lay out the 14 bolt holes, drill the four in the corners clearance size, and spot, drill, and tap the corner holes in the cylinder steam-part face. Bolt through the four holes, and drill the remaining 10 tapping size through the steam chest into the cylinder. Separate the parts, tap the cylinder holes, and open up those in the steam chest.

Face the steam-chest cover in the lathe, mill the recess, clamp the steam chest to it in the drill press, and drill the bolt holes.

The valve-stem guide, and steam-pipe flange are turned from bronze bar stock to dimensions on page 193.

TO BE CONTINUED

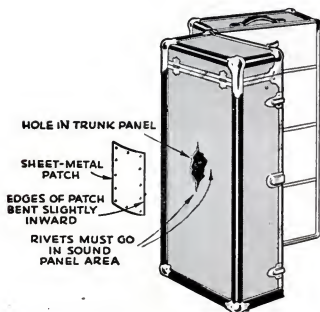


Collet and Arbor Simplify Mounting Small Wheels in Lathe

WHEELS, pulleys, and collars are centered automatically on the end of the rod inserted in this collet and end plug, and they can be reversed for turning the opposite face without losing time in recentering. The work is held firmly by pulling the lefthand nut up tight. Use free-cutting brass for the head

with the taper boss, and steel for the rod.

Lathe spindles vary in length, bore, and taper, and the dimensions shown should be changed to suit. The arbor will take work centerdrilled the size of the rod; a set of bushings can be turned for work having larger center holes.—HERBERT PFISTER.



Steel Patch for Damaged Trunk

TO REPAIR a hole broken in a trunk panel, cut a sheet-steel patch large enough for rivets to go into sound material around the break. Smooth the edges, or bend them slightly in, and put the patch on the outside. House paint or thick spar varnish between panel and patch strengthens the joint and makes it water resistant.

Tire-Cut Filler Insulates Plug

For a completely insulated, solid electrical plug, fill the inside with tire-cut filler after the wire connections have been made. Press the



filler in with a moistened finger. When dry, it is like molded rubber and will prevent the wires from loosening.—KENNETH MURRAY.

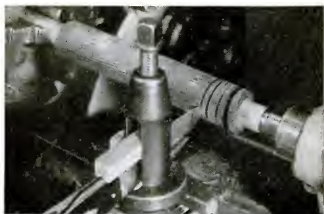
Paint for Frosting Windows

GLASS must be thoroughly clean before it can be painted successfully. A mixture of rubbing alcohol, household ammonia, and powdered whiting will remove all dirt and grease. Wipe clean with a dry cloth.

For the frosted effect, mix a paint of 3 parts white lead, 1½ parts boiled linseed oil, and ½ part spar varnish. Apply with a wide brush in small squares and, after each square is painted, stipple with a bag made of several folds of cheesecloth wrapped over a ball of cotton.—JOSEPH E. BIRD.

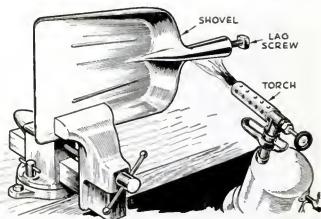
Rubber Washers Made in Lathe

DOZENS of washers can be cut in a few minutes from a length of old rubber hose. Insert a dowel in the hose and mount the piece in the lathe. Clamp a heavy knife under a block in the tool post or hold it on the tool rest of a wood lathe.—WILL THOMAS.



Cardboard Guards Piano Finish

WHEN a piano is played often, the finish on the piece between the keyboard and the music rack is in danger of becoming so badly marred by the fingernails that a re-finishing job may be necessary. A length of cardboard inserted in the space, however, will protect the original finish. Inserted behind the black keys as a tight fit between them and the overhang above, it won't interfere with playing.



Freeing Broken Shovel Handle

A SHOVEL handle that has broken near the shank may be removed by driving a heavy lag screw into the end, clamping the blade in a vise, and heating with a blowtorch. When the wood has charred sufficiently, pull the lag screw with pliers.—RONALD EYRICH.

CONCRETE AGGREGATE

[HANDY MAN]

Both coarse and fine aggregate are required in strong cement. The coarse aggregate consists of crushed stone or pebbles graded in sizes from $\frac{3}{4}$ " to $1\frac{1}{2}$ " or up to 3" for mass concrete work. It should be clean and hard. Fine aggregate is sand, graded from very fine to $\frac{1}{4}$ ", and should also be clean and hard. By graded is meant that the aggregate should contain many sizes from small to large. In the mixture, the small particles fill the voids between the large, while the cement fills the voids between the small particles.

Bank-run gravel, that is, the natural deposit of combined sand and pebbles, may be used for aggregate if it is clean, but for best results it should be screened, the sand separated from the pebbles, and reportioned. As it comes from the bank, gravel usually contains a greater amount of sand than required.

Dirty sand may be made suitable for use by washing with a hose on an inclined shallow trough fitted with cleats and having a screen at the lower end to separate sand from pebbles. A trough should be provided to drain off water from the receptacle under the screen. The unwashed sand is, of course, put on at the top of the incline and washed down. Two or three washings may be required, for if silt, clay, and loam are mixed in the concrete, they will coat the aggregate and prevent bonding by the cement.

What is known as "cinder concrete" can be made of cement mixed with cinders for aggregate. It is cheap and light in weight and is used chiefly for floors that will not carry heavy loads and in some fireproof structural-steel work. The cinders should be hard-burned boiler cinders free from fine ash. They should be wetted 24 hours before use to slack out free lime and neutralize sulphur. The proportion is ordinarily 1 part cement to 5 parts cinders. Don't attempt to use household cinders; they are too fine and powdery.

POPULAR SCIENCE MONTHLY SHOP DATA



Light and shadow cast on a wall will form interesting backgrounds for your home camera portraits. Designs are limited only by your imagination and ability to wield a pair of scissors.

Patterns are cut out from black paper or cardboard. They may be symmetrical or irregular in design. The pattern for the background at left is shown below.



SHADOW BACKGROUNDS

Set Picture Moods

By LOUIS HOCHMAN

ONE of the most limiting obstacles faced by the amateur portrait photographer who works in his own home is the lack of a variety of backgrounds. Blinds, drapes, and the materials at his disposal can go just so far before their possibilities become exhausted.

Yet, with scissors, black paper, and imagination, he can convert a light-colored blank wall into such an endless variety of artistic background effects that his home portraiture will never be in danger of slipping into a commonplace rut.

It's really a very simple trick. Cutouts are made in sheets of black paper to form interesting patterns, and a sheet is set up in

front of a light directed on the blank wall. The shadow of the cutout pattern is thus cast on the wall. All that then remains is to pose the subject in front of the tracery of light and shadow and, after lighting him suitably, to take the picture.

The accompanying illustrations can but suggest a few of the designs that can be cut from black paper. Patterns may be symmetrical or haphazard, bold or subtle, fine or coarse. Anything that comes to mind and can be transferred to black paper with a few snips of the scissors may be worth trying. The shadow design is especially appropriate if it helps to set a mood for the portrait.

One of the simplest ways to cut symmetrical patterns, of course, is to fold the paper

into quarters or eighths. The design is cut at one time in the folded sheet, which is then spread out to reveal the cutout repeated in every section of the paper.

A most suitable material for such work is the black paper in which films and photographic papers come packed. Excellent large sheets of black paper, for instance, are used for wrappings on 8" by 10" paper in boxes of a gross sheets. If the paper is not large enough, two or four pieces can be taped together. Sheets measuring 16" by 20" should prove large enough for most designs.

When more permanent patterns are desired, thin cardboard may be used. It should be coated with a dull black paint. Some difficulty may be experienced in cutting symmetrical designs on such cardboard unless they are first cut out on folded paper and then traced on the cardboard.

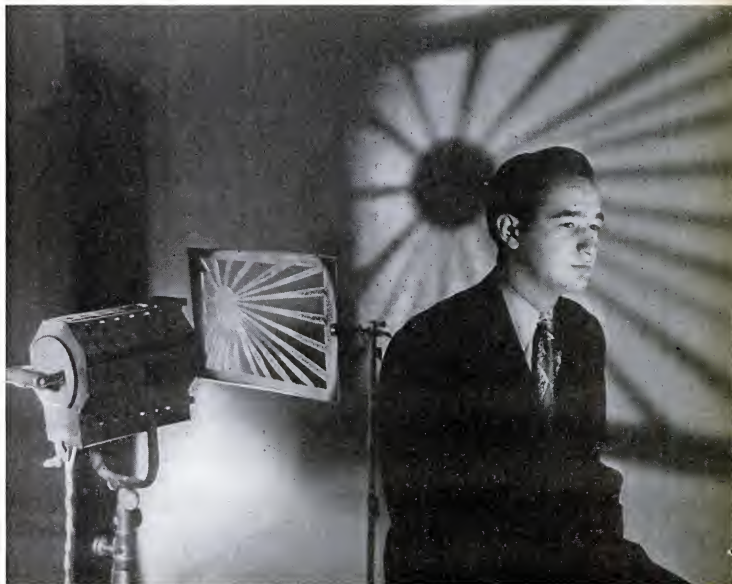
For pattern ideas, you need only study

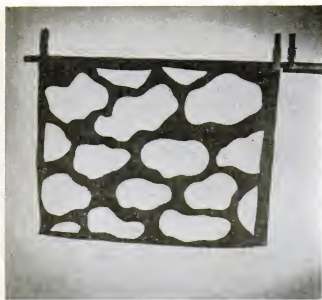
everyday objects. A brick wall, a flagstone walk, foliage, a picket fence, the rays of the sun, wagon wheels, latticed windows—all suggest good designs. Precision is not necessary in cutting (a razor blade may be used as well as scissors) for the shadows will be fuzzy anyway when cast on the wall. This fuzziness, however, adds to rather than detracts from the pictorial effect.

The pattern is suspended in front of a light beam directed on the blank wall. Remember that the closer the light is to the pattern, the fuzzier will be the edges of the shadows, and the farther away, the less fuzzy the design will show. Where a relatively sharp design is required, the pattern will have to be exceptionally large and placed as close to the wall as possible without interfering with the subject.

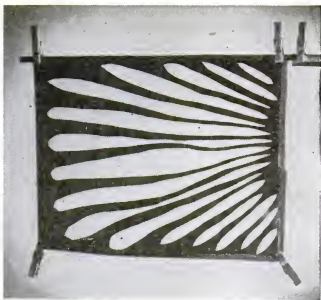
Also affecting the sharpness is the kind of light used. For best results, the source

This is how the pattern background is projected on the wall. A spotlight behind the cutout throws the shadow design on a blank space. The light should be placed at a 45-deg. angle so as not to hit the subject.





One of many patterns possible with cutouts. They may be suggested by a flagstone walk, a latticed window, a picket fence, and other common objects.



Spring clothespins attach the pattern to the arm of a supporting stand. Clothespins on the lower corners add weight to hold the pattern straight.



Looking up to the sun. This portrait effect is obtained with a simple cutout simulating rays. Mood effects like this help keep portraits out of the commonplace.

should be as nearly a pin point as possible. A small focusing spotlight with lens removed or a clear 500-watt projection-type bulb without a reflector serves well. The shadow should be cast from an angle of about 45 deg. so the subject will be able to pose in front of it without having it on him.

In lighting the subject, take care to keep bright light from striking the background and killing off the shadow pattern. The subject lights should be well shielded and directed from steep angles when possible.

Such cutouts are a boon also for the color photographer. With gelatin sheets of various colors taped over the cutouts, rich and colorful backgrounds can be obtained. Or a play of shadow and one color is possible with a gelatin sheet held in front of the light.

An interesting rainbow effect can be created with semicircles of red, yellow, green, and blue gelatin mounted together over a cardboard frame with cellulose tape. Such a pattern can be projected on the wall.

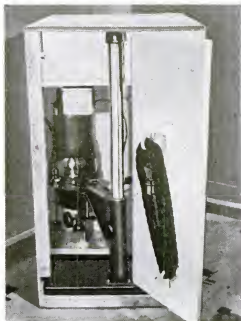
Lighting intensity on subject and background should be balanced. The color temperature of the light used to project a rainbow is unimportant, but the lights on the subject should be of the correct Kelvin temperature for the film.

END



Darkroom in a Box

AMATEUR photographers who lack space for a complete darkroom can take a tip from Walter O. Englund, of Marietta, Ga. He stores every item of his equipment in a handsome plywood cabinet finished to harmonize with the rest of the room furnishings. Measuring 19" deep, 26" wide, and 33" high, the cabinet was so designed that each bit of equipment has its allotted niche. In use, the top of the cabinet provides a resting place for the enlarger, and the only other thing required is a table for trays.



Storage for the enlarger is provided in the left end. Negative carriers and a foot switch go above it, and hooks on the door take a long extension cord.



Open the front doors, and this is what you see. The compartment at the right will take 11" by 14" trays if the bottom shelf is removed. On the right door are hooks for film clips and a print roller. In the right end are four drawers for storage of paper.

On the back (right) are three electrical outlets. The top one and that at lower left are in series so a foot switch can be used with the enlarger. A safelight is connected to the other.

Shelves that are reached by lifting the top provide space for ferrotype tins, 11" by 14" paper, scales, film, and negatives.

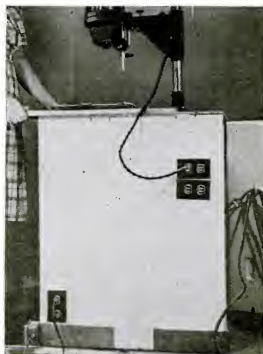
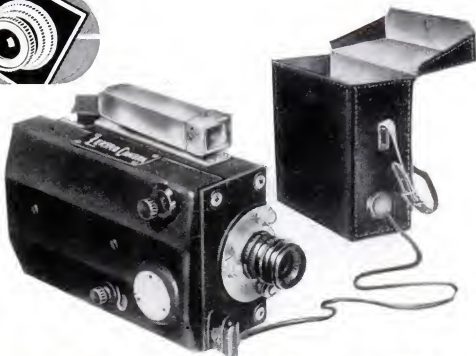


PHOTO IDEAS and EQUIPMENT



ELECTRIC DRIVE. A continuous-action movie camera, adapted in a lightweight edition from cameras mounted in the wings of warplanes, is driven by a special dry-cell pack housed in the case. Called the LectroCamera, it is distributed in three models, one including sound speeds, all under \$140, by Associated Photo Products, of New York.



FIXPECTION LIGHT. If you can't wait to inspect prints until they are out of the fixing bath, a 10-watt bulb suspended 6" to 8" above the bath will provide safe illumination so long as you keep the print submerged in the hypo. A shade made from a small can painted black outside and with aluminum paint inside will prevent fogging of other paper. Turn the light off when not in use.—J. L. VAN HORNE.

PHOTOGRAPHIC ANALYZER. Density and contrast are measured by a photocell on the arm of the instrument shown at right when a negative is placed over the illuminated viewer. The device will also analyze contrast in printing papers and exposures for prints and enlargements. It can be used both for black-and-white and color. Weston Electrical Instrument Corporation, of Newark, N. J., is the maker.

TRIPOD-TOP AID.

When the socket on a camera, particularly a miniature camera, isn't deep enough to receive the full length of the tripod screw, a rubber garden-hose washer over the screw will prevent wobbling. Used on a metal tilt top, a washer also helps to keep a camera from rotating out of its set position.—JACK WILSON.





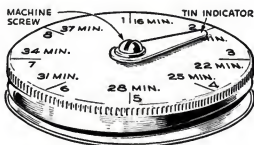
SYNCHRONIZER FOR BANTAM. A special automatic synchronizer has been developed by the Kalart Company, Inc., of Stamford, Conn., for Kodak Bantam cameras with $f/4.5$ or $f/5.6$ lenses. Small enough to slip into a coat pocket, this Compak Automatic Speed Flash has a reflector designed to increase the light efficiency of midget bulbs more than 80 percent. It is easily and quickly installed or removed.

CORD KEPT SECURE. As a precaution against bulb failure due to loose connections when you are taking flash pictures with an extension unit, secure the extension cord to the battery case or reflector bracket with a half hitch.—JACK WILSON.



BLACK AND WHITES FROM COLOR. A kit placed on the market by Grant Photo Products, Inc., of Cleveland, Ohio, employs the reversal system to get black and white or sepia prints from color transparencies. All the necessary chemicals and a package of panchromatic reversal paper are included. Because the emulsion is coated on a waterproof base, a print can be developed and fully washed in only 5 min. working time after exposure in an enlarger.

RIBBON LIFTS PAPER. A short ribbon or string attached to a cardboard stiffener in the bottom of a box of printing paper makes it easier to remove paper without fumbling. Pulling on the ribbon raises the upper sheet within convenient reach of your fingers.



DEVELOPING AID. This indicator helps me keep track of the number of times I have used my film developer and shows at a glance the developing time required for each successive batch of film at 68 deg. F. It is made from a jar lid, an indicating hand being cut from a piece of tin and mounted in the center with a machine screw, a nut, and three washers.—KENNETH CLARK.

Businessman's Radio

By EDWARD BLANTON

FOR THE businessman who has to travel and likes to travel light, here is a handy radio that manages to be a constant companion without becoming an extra piece of luggage. Flat enough to fit into a briefcase or overnight suitcase without crowding out the other things you want to take along, this four-tube receiver operates on either AC or DC at 115 volts.

The resistance of the four tube filaments in series is such that no line-cord resistor is needed to drop the voltage. Therefore an ordinary two-conductor cord can be used, as long or as short as you like. A little extra length is all to the good, since in some of the older hotels electric outlets aren't placed as close as you might like to the desk or night table.

All the tubes are midjets; leads from inside are brought out to miniature metal prongs embedded in the glass envelopes. Connections are made to miniature 7-prong

sockets that are fastened to the chassis.

The chassis consists of a $5\frac{1}{2}$ " by 8" sheet of thin aluminum bent to form a 90-deg. angle about 2" from one of the longer edges. Most of the parts are fastened to the 2" leg so formed.

The first tube, a 12BA6, is a radio-frequency amplifier pentode with remote cut-off characteristics. The control grid of the tube is connected to the secondary winding of the antenna coil (L1) and the stator plates of one section of the two-gang tuning condenser (C1). From the plate of the 12BA6, the amplified radio-frequency signal is fed into the primary winding of the RF coil, L2, which is coupled to a second tank circuit composed of the secondary of the RF coil and the other half of C1.

The unshielded antenna coil is placed beneath the bend in the chassis; the RF coil is placed above the chassis and must be shielded to prevent oscillation and distortion due to stray couplings between the coil windings and the other circuit components.

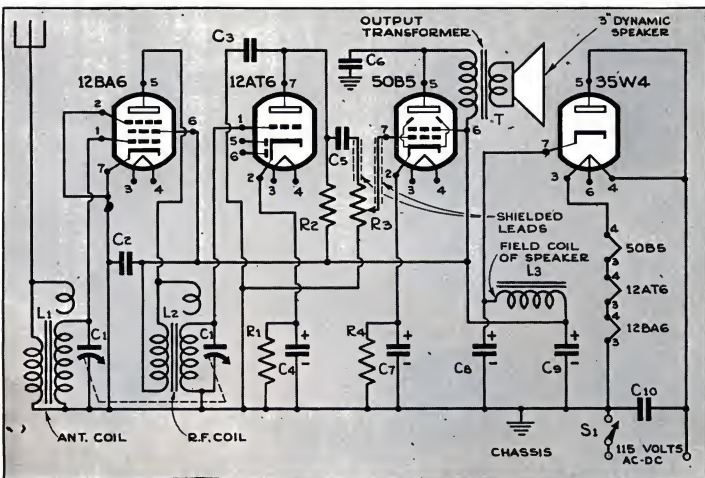
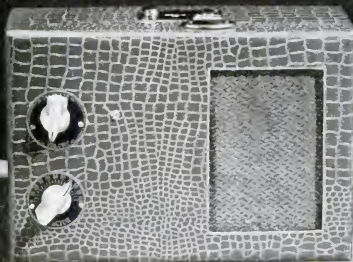
To cover the coil, a portion of an old tube shield was cut off and bolted to the chassis as illustrated on page 207.

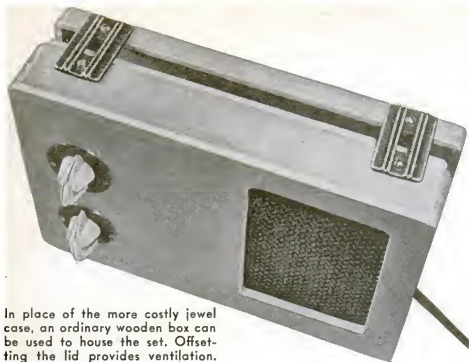
Output from the RF tank circuit is fed to the grid of the 12AT6, used as an anode detector and amplifier. Bias is provided by a 2,700-ohm resistor and a 10-mfd., 25-volt electrolytic condenser (R1, C4). A small mica condenser



An average-size briefcase holds the radio and plenty of books, papers, and other articles as well. The case is a leather-covered jewel box or accessory case.

Fits in a Briefcase





In place of the more costly jewel case, an ordinary wooden box can be used to house the set. Offsetting the lid provides ventilation.

(C3) in the plate circuit of the tube bypasses stray RF signals to ground before they can get into the audio system and introduce unwanted noise.

Resistance coupling is employed between the detector and audio stages. For the latter, a 50B5 beam-power pentode is used. A 1-meg. variable resistor (R3) in the grid circuit of the tube acts as a volume control. For bias, a 270-ohm resistor and another 10-mfd. electrolytic (R4, C7) are used.

All of the electrolytics in this set are of the dry type, encased in tubular aluminum shells and wrapped in heavy paper. These electrolytics require no mounting brackets as they are small and light enough to be supported by their own pigtail leads. Polarity is important in wiring electrolytic condensers. The "plus" and "minus" leads must be connected as indicated in the diagram. Should the leads of an electrolytic be reversed, it may start to "boil" and will quickly short or otherwise become inoperative.

The midget output transformer, mounted on the underside of the speaker frame and projecting through an opening cut in the chassis, couples the output from the plate of the 50B5 with the 3" dynamic speaker. To match the impedance of the tube to that of the voice coil, the transformer should have a primary impedance of 2,000 to 3,000 ohms and an impedance in the secondary winding of about 4 ohms.

For the filter choke, L3, the 500-ohm field coil of the speaker is used. This value isn't critical; any field coil from 500 to 1,500

ohms will serve. Small 16-mfd. electrolytic condensers are connected to both sides of the coil.

A rectangular speaker opening approximately 3" by 4" is cut in the front panel of the case and covered on the inside with a suitable grille cloth. Since the speaker is mounted on the aluminum chassis, it is not necessary to bolt it to the cabinet. Two 1/2" dia. holes are drilled in the front of the cabinet to clear the tuning-condenser and volume-control shafts. These two shafts, supplemented by one nut and bolt, should be

sufficient to hold the aluminum chassis firmly against the front of the cabinet.

The cabinet itself consists of an imitation-leather covered jewel box measuring 3" by 6" by 9" which allows slight clearance for the chassis on all sides. A rectangular opening is cut in the back of the box and covered on the inside with wire mesh. This is necessary to provide adequate ventilation for the set. With a case of this size, both the line cord and a 25' length of antenna wire can be coiled inside for easy transportation.

The photo on this page shows an alternative and less expensive cabinet made of a small wooden box purchased at a crafts

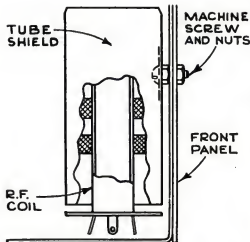
LIST OF PARTS

- C1: 360-mmfd. two-gang tuning condenser.
- C2, C10: .01-mfd. paper tubular, 400 volts.
- C3: 250-mmfd. mica.
- C4, C7: 10-mfd., 25-volt electrolytic.
- C5: .02-mfd. paper tubular, 400 volts.
- C6: .005-mfd. paper tubular, 400 volts.
- C8, C9: 16-mfd., 150-volt electrolytic.
- R1: 2,700-ohm, 2-watt carbon.
- R2: 150,000-ohm, 1-watt carbon.
- R3: 1-meg. volume control with switch. See S1.
- R4: 270-ohm, 2-watt carbon.
- L1: Adjustable iron-core antenna coil.
- L2: Adjustable iron-core RF coil.
- L3: Field coil of speaker used as filter choke.
- S1: S.P.S.T. on volume control R3.
- T: Output transformer.
- Tubes, wafer sockets, 3" electrodynamic speaker, dial plates, knobs, misc. hardware.

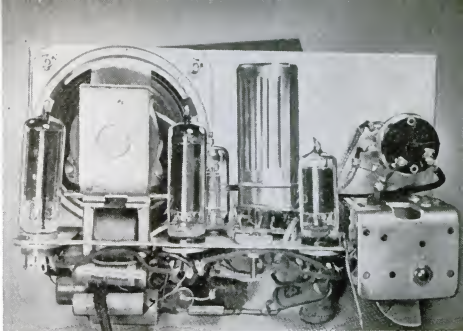
store for less than a dollar. The lid of this box is mounted on the body with metal brackets, providing a $\frac{1}{2}$ " wide air space to allow ventilation for the tubes on all sides. With such all-around cooling, the set may be played while it is lying on its back or on any of its sides. Although somewhat less handsome, a cigar box with a ventilation slot will be as serviceable.

In common with most AC-DC sets, the chassis of this receiver is grounded to one side of the power line. Therefore no external ground should be used. A hank of antenna wire thrown out the window or strung along the floor is sufficient to pick up most local stations. It must be noted, however, that this is a TRF circuit and its selectivity is not as great as that of a superheterodyne. Nevertheless, it should be sufficient to separate transmitters in most localities. When using the set on DC, remember to reverse the plug if the radio fails to play on the first try.

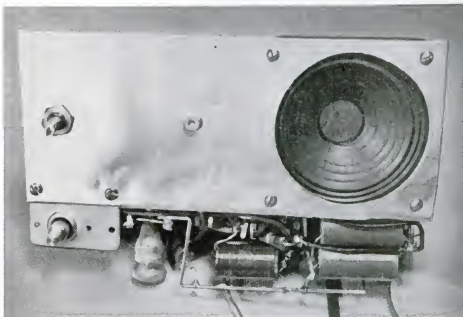
If you like radio novelties, you may want to try putting this compact circuit, perhaps rearranged on a more suitable chassis, into a banjo clock, a table lamp, a book cover, a night table, or even a ship model.



To prevent oscillation and distortion due to stray coupling, the RF coil must be shielded. A suggested method for isolating the coil is to enclose it in an old tube shield which is attached to the chassis as shown above.

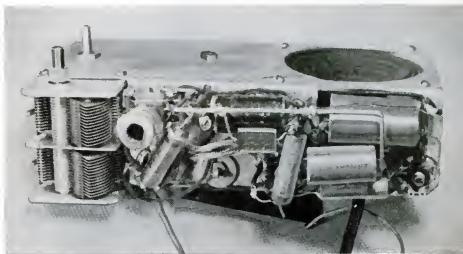


The chassis is a sheet of aluminum bent to the shape of a long "L." Most of the parts are attached to the projecting ledge.



Front view of the chassis. Matching holes are cut in the cabinet for the speaker and volume-control and condenser shafts.

Aside from the tubes and speaker, most of the parts are mounted below the bend in the chassis, as shown in the photograph below.

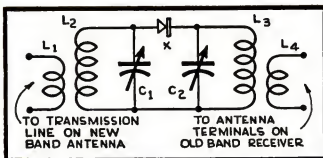
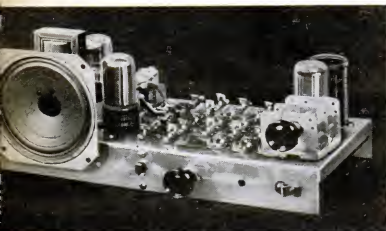




NEWS IN ELECTRONICS



EXPERIMENT KIT. A package that supplies all the parts needed for building such electronic devices as a radio receiver, photoelectric relay, and a remote tuner, is sold by Deer & Taylor Co., of Berkeley, Calif., for about \$40. The chassis has a few fixed parts and an array of clips to which the removable parts supplied with the kit may be connected. An accompanying manual shows hookups for 18 circuits.



- C1, C2: 8-plate midget air trimmers.
 L1: 2 turns No. 18 insulated hookup wire interwound with L2.
 L2: 4 turns No. 10 solid enameled wire space wound 7/16" dia.
 L3: 10 turns, otherwise same as L2.
 L4: 3 turns No. 18 hookup wire interwound with L3.
 X: 1N34 crystal.

FM CONVERTER. Old-style FM sets decrease in usefulness as transmitters continue to switch over to the new frequencies around 100 megacycles. Many converters have been offered to salvage these sets, at least in part. One of the most interesting is the design of Henry R. Kaiser, chief engineer of Pittsburgh's WWSW and its FM affiliate, WMOT. The simple circuit shown above evolved accidentally when the tube of a one-tube converter failed. The signal continued to come through just as well.

Empty baby-food cans are used to house the coils, trimmers, and crystal, and the units are assembled by the station staff. They are sold to local set owners for \$2.39, representing the cost of the parts. No distribution is planned outside the station's service area. Early tests of the converter covered only a few stations operating at the low end of the band (below 95 mc.). The input circuit is tuned to the transmitter frequency and the output to a frequency within the range of the receiver. The coils must be placed near the receiver.

ANOTHER CONVERTER.

This one, slated for national distribution, is made by the Waterproof Electric Company, of Burbank, Calif. The unit measures approximately 1½" by 2" by 4" and weighs less than 1 lb. It is intended to cover all the frequencies of the new band.





WIRE STRIPPER. Enamel, impregnating varnish, plastic, and other insulating coatings are chemically removed from wires by this cold wire stripper made by the Ellanar Chemical Company, of Chicago. The wire is immersed in the liquid for from 15 sec. to 2 min. depending on the type of coating, after which the insulation can be wiped off leaving the wire clean and ready for use.

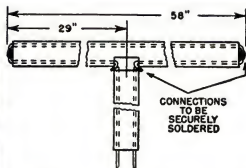
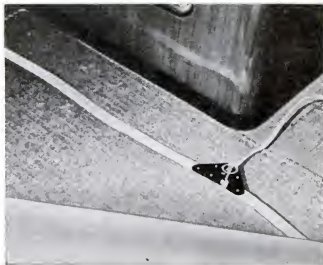


SELF-HEALING CAPACITORS. A wartime German invention is responsible for these tiny tubular condensers made by depositing metallic coatings directly on an insulating paper. If a short develops, the resulting arc not only oxidizes the shorting metal, but also deposits an insulating coating of aluminum oxide. They're made by Solar.

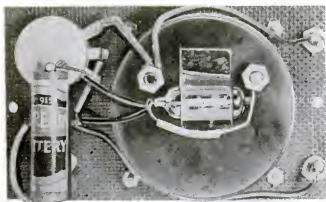
FM ANTENNAS. In many areas where FM receivers are close to one or more transmitters, properly designed antennas can be placed in any convenient indoor location and still give adequate results. The Hallicrafters Co., of Chicago, makes the under-rug dipole antenna shown at the right. It has two flat aluminum blades extending on either side of the center lead-in. The arms are the correct length for the new bands, and the lead-in consists of a ribbon-type concentric line. The antenna may also be hung on a wall.

For the set owner who wants to build his own, an antenna similar in appearance and use is suggested by Federal Telephone and Radio Corporation. The K-1046 lead-in cable made by this company has an impedance of 300 ohms—the conventional input impedance of FM and television sets. A perfectly matched antenna can therefore be made out of a cable cut to half the wavelength of the band to be received. Figures in the diagram are for the new FM frequencies. The ends are shorted, soldered, and covered with an insulating

lacquer. For the lead-in, one side of the cable must be cut at the exact midpoint. The insulation is stripped back an equal distance in both directions, but it is important that the width of the separation exactly equal the conductor spacing of the lead-in. The cable itself is of the low-loss, weather-resisting type that may be used indoors or outdoors depending on the signal strength.



Dimensions given above are for a new-band FM antenna. Both the length and location of the lead-in are critical.



Connections on the underside of the meter. The midget triode used was taped to the milliammeter.

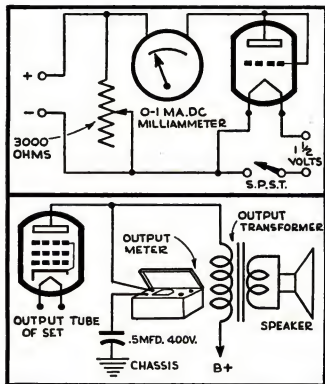
OUTPUT METER

Uses 1½-Volt Tube

FOR accurate alignment of the stages of a superhet or TRF receiver, where the ear can't catch minute variations, an output meter is an inexpensive aid. Such a meter is also valuable when hooked up in a public-address system or with a home recorder for regulating output level during operation.

A midget war-surplus triode having a 1.4-volt filament was used as a diode detector in the meter shown, being secured with tape to the back of the 0-1 ma. D.C. milliammeter. A more readily available R.F. pentode, the 1T4, may be substituted by tying its grids and plate together. This tube will fit a button-base socket. Tape holds the 1.5-volt battery filament supply. A 3,000-ohm variable resistor across the meter input prevents overloading and keeps the needle on the scale. The housing is a card-file box.

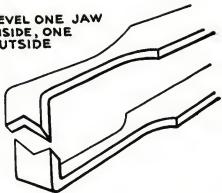
In use the meter is connected across the secondary of the speaker transformer, in parallel with the voice coil (as in the photo above), or directly across the plate of the output tube and ground through a condenser (as in the drawing). The last increases sensitivity tenfold for weak signals. Adjust receiver trimmers for maximum scale deflection. If noise is objectionable in aligning I.F. transformers, disconnect the speaker.



Maximum sensitivity of the needle is obtained by connecting across the output plate to a ground.



BEVEL ONE JAW
INSIDE, ONE
OUTSIDE



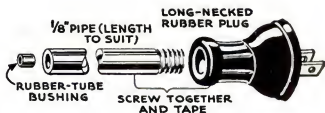
Fine-Wire Insulation Stripper Made from Dime-Store Tweezers

PARTICULARLY useful for light electrical work, this handy insulation stripper can be made from a pair of blunt-end tweezers. First file the tips as shown above and bend

them inwards at right angles so that the jaws just overlap. To use, press the cutting edges on the wire, twist to cut the insulation, and then pull.

Pipe Fastened in Plug Neck Reaches Inaccessible Outlet

IF AN electric cord must frequently be plugged into an out-of-the-way outlet on the ceiling or behind furniture, a reach plug can make life a bit easier. Into a long-neck rubber plug (the type designed to give ample finger grip) screw a suitable length of $\frac{1}{8}$ " pipe threaded at the end. A few turns will join the plug and pipe firmly. Tape the joint for extra strength, and bush the other end of the pipe with a short piece of windshield-wiper tubing to protect the cord from fraying at this point.

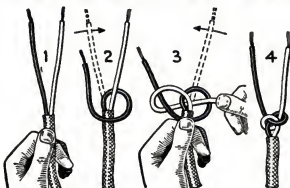


Pipe Cleaner Separates Wires

CIRCUIT wires grouped and bound together simplify servicing and repairs. Pipe cleaners will hold the wires neatly and can be color-coded with nail polish or enamel.

UNDERWRITERS' KNOT

[ELECTRICAL]



INSULATION
RIGHT UP TO
SCREW HEAD

Electrical wiring is not considered safe unless it has a margin of safety great enough to protect it against unforeseen and excessive strains. Thus, while it is not good practice to pull a plug out of a socket by yanking the cord, some method for taking up such strains should be provided at the time the wiring is done. One recommended procedure is the so-called underwriters' knot illustrated at the left. Before wires are connected to the terminal screws of a plug, socket, or other fixture, knot them as shown to keep sudden pulls from being transferred directly to the terminals. An alternative or supplementary method for taking up strain on plug wires is pictured at the lower left. It consists of leading the wires around the prongs as shown before attaching.

POPULAR SCIENCE MONTHLY SHOP DATA

How Spontaneous Combustion Happens

By KENNETH M. SWEZEY

FIRE that breaks forth from a substance without the application of external heat has long been a source of mystery and consternation. Without visible cause, flames burst from an innocent-looking haystack or pile of coal; a wad of cotton waste, soaked with oil, sets fire to a garage; a chemical mixture that ordinarily is harmless suddenly blazes up violently.

Thanks to modern research, chemists now know the reason for almost every type of spontaneous combustion. Barring ignorance, carelessness, or accident, fires starting from this source can be prevented. In most cases the actual visible combustion is just an ordinary fire in which a combustible material has been raised to its ignition point by slow oxidation or other chemical reaction. In the remaining cases, all particularly important to the chemical worker, heat and flame are produced in a reaction involving substances other than oxygen.

Heat is generated every time a substance is oxidized. If the oxidation is extremely fast, we may see fire. If it is slow enough, as in the rusting of iron or the drying of paint, the heat is dissipated so fast that it is impossible to detect any rise in temperature. If, however, we increase the speed of slow oxidation, decrease the rate of heat dissipation, or both, until heat is generated faster than it can be dissipated, we have a starting point for spontaneous combustion.

Breaking a substance into small particles is one way to speed up oxidation and at the same time reduce the rate of dissipation. The smaller the particles, the larger the surface area to react with oxygen and the smaller the mass to dissipate heat. For instance, iron powder that has been freshly prepared by reduction with hydrogen will heat to the point of glowing when exposed to air, and heaps of fine coal particles are far more liable to smoulder and burst into flame than piles of large chunks.

With a tiny piece of phosphorus and a teaspoonful of carbon disulphide, you can

present a spectacular demonstration of the effect of subdivision. Unless the room temperature is high, a solid lump of phosphorus left exposed to the air will catch fire only very slowly, if at all. Finely divided, however, it ignites almost instantly.

Although this experiment is perfectly harmless if performed as directed, be extremely careful in handling both of these chemicals. *Keep the carbon disulphide far from any flame, and keep phosphorus, or any solution of it, off your hands, clothes, or anything inflammable. Always handle the phosphorus with tweezers and cut it under water. Dispose of any remaining solution by allowing it to burn in an open pan.*

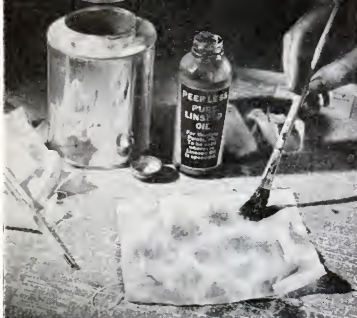
By gentle shaking, dissolve a piece of phosphorus about half the size of a pea in 5 ml. of carbon disulphide in a test tube. Use an ordinary cork as a temporary stopper for the tube, as carbon disulphide and its vapors attack rubber. After supporting



1 Dissolve a tiny piece of yellow phosphorus in carbon disulphide, dip a paper napkin into the solution, remove, and hold it away from your face.



2 The paper will soon burst into flame. An example of spontaneous combustion, the fire is set by oxidation of phosphorous particles left after the liquid evaporates. (Caution: read text before trying this.)



Rags soaked with oil or paint often catch fire spontaneously as a result of the heat produced by linoleic acid in the oil combining with oxygen to form linoxyn. To show this effect, daub some drying oil on several rags, stuff them into an insulated can, and set a thermometer in the midst of the rags.



Sulphuric acid has such an affinity for water that it will remove hydrogen and oxygen from the above carbohydrates, creating considerable heat, leaving a carbon residue, and sometimes starting a fire.

Potassium chlorate mixed with powdered sugar is normally stable, but add a drop of sulphuric acid to this mixture and you get the result at right.



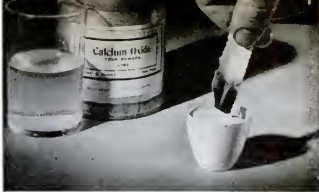
the test tube in a tumbler so your hands will be free, dip the end of a strip of filter paper or paper towel, held in tongs, into the solution. Remove it, quickly stopper the tube, and hold the paper in the air, away from your face.

Nothing will happen as long as any carbon disulphide remains. But this solvent quickly evaporates, leaving finely divided phosphorus on the paper. In a flash, this phosphorus unites with oxygen, heat is generated faster than it can be carried away, and the phosphorus and paper burst into flame.

You can also speed up oxidation and reduce heat dissipation by spreading a substance so thinly that its surface is large compared with its mass. Such thin spreading of oxidizable material is the cause of spontaneous combustion in oily rags.

Most vegetable and animal oils, such as linseed, tung, olive, and cod liver oils, contain linoleic and other fatty acids that react with oxygen at ordinary temperatures to produce the solid substance "linoxyn." As in all oxidations, heat is produced in this reaction. Ordinarily, when such oils are in bulk or are spread in paint over a large open surface, the heat is carried away as fast as it is produced. But spread such oils on the fibers of rags or waste and confine the rags or waste so the heat cannot escape, and the story is different. Little by little, the heat increases until finally the ignition point of the cotton is reached and the cotton and oil go up in flames.

You can easily prove that drying oils generate heat. Place a small tin can inside a larger one and insulate one from the other with cotton, asbestos wool, or sawdust. Next paint a few pieces of cotton cloth with dabs of ordinary paint or a drying oil. (Oxidation takes place more rapidly if all the pores



Water added in the right proportion to quicklime (calcium oxide) generates heat sufficient to char paper. Wood also could be ignited by this reaction.

At the left, turpentine-soaked cotton burns when thrust into a beaker that contains chlorine gas.

and fibers are not completely covered with oil.) Then pack these paint-dabbed rags around the bulb and stem of a thermometer until the small can is full. Finally, set the apparatus in a moderately warm place and note the thermometer reading periodically. The temperature will rise as the oil unites with oxygen from the air.

In the chemical laboratory, there are many substances that may react spontaneously. That is one reason why home and student chemists should never mix chemicals together, hit-or-miss, to see what happens. When performing an unfamiliar experiment, you should follow instructions to the letter.

It would take several volumes to list all the chemical reactions that might produce fire or at least considerable heat, but you can easily demonstrate a few.

All chemists are familiar with the heat produced when sulphuric acid is added to water. (It is because of this that water must never be added to the acid, for the water, being lighter than acid, would remain on top, where it would be heated to boiling by the strong reaction, with the result that both water and acid might spatter explosively out of the container.) But how many know that heat also is produced when the concentrated acid is dropped on wood, paper, or textiles—enough heat, sometimes, to start a fire? This acid has such a great affinity for water that it removes hydrogen and oxygen, in the exact proportions in which they occur in water, from such carbohydrates, leaving a residue of carbon.

As a demonstration of this, place a drop of the acid on a piece of paper, cotton cloth, or wood. In each case, the substance will become charred.

Some substances that normally are stable when mixed may react violently if a third

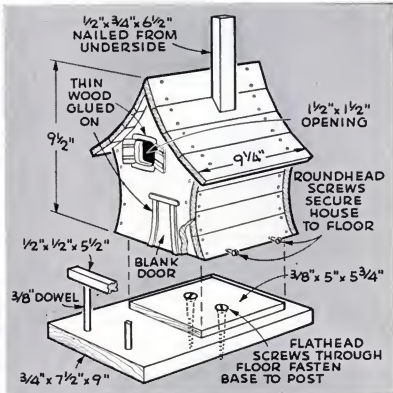
substance is added. Potassium chlorate and powdered sugar are such a combination. Mix carefully 1 g. of powdered potassium chlorate with 2 g. of powdered sugar. (Never *grind* potassium chlorate with sugar or any other organic chemical, as the heat of friction may cause an explosion. However, you may grind either chemical *separately* in a clean mortar and then stir them together gently on a piece of paper.) After the two substances are mixed, place about a fourth of the mixture in a little heap on an inverted can cover or pie tin that, in turn, rests on a table covered with newspapers to catch any possible splatterings.

Then add just one drop of concentrated sulphuric acid to the center of the heap and quickly stand back. In a second, the sulphuric acid unites with the potassium chlorate, forming chloric acid. This oxidizes the sugar so rapidly that fire results.

Many chemical substances catch fire when brought into contact with chlorine, bromine, or iodine. Turpentine vapor is one of these. You may prove this by first filling a tall glass or beaker with chlorine (made by gently heating a little manganese dioxide and hydrochloric acid in a flask and leading the outlet tube from the flask down into the glass, where chlorine replaces the air) and lowering a small wad of cotton, soaked in warm turpentine, into it. In a moment, the turpentine will blaze spontaneously.

Even water has been known to start a fire when mixed in the right proportions with ordinary quicklime (calcium oxide). To verify this heating effect, put a teaspoonful of quicklime into a small crucible, packing around it a strip of paper. Then add half a teaspoonful of water. After five minutes, remove the paper, and you will find at least a part of it charred.

END



Bird House in Fairyland Style Is Built of Packing-Case Wood

FOR those who have a favorite pair of bluebirds nesting in their garden, a house built in the manner of those in children's fairy-tale books makes a simple yet attractive project. The storybook appearance comes chiefly from the freehand curves of the roof line and sides. Draw these full scale on a sheet of heavy wrapping paper, cut out the outline, and use it as a pattern for jigsawing the front and back. Such stock as the ends of orange crates or $\frac{3}{8}$ " packing-case wood will be satisfactory.

Cut out a second front and back, making them narrower than the first pieces by twice the thickness of the stock to be used for the

sides. Then nail boards for the sides to the narrower pieces, choosing their widths from scrap stock to fit more or less in the curves. The wider front and back are nailed on last. Corner joints thus made will be windproof and snug. Nail on the roof and cover it with an asphalt shingle, allowing $\frac{1}{4}$ " to overlap all around. The chimney is a solid block beveled on the lower end to fit the roof slope. Toenail it in place.

The base, containing a perch and a block for the floor, is screwed permanently to a post. Screws through the sides into the floor permit removal of the house from the base for cleaning.—DICK HUTCHINSON.



Climbing Pole Develops Arm and Shoulder Muscles

THIS climbing pole is ascended and descended with the aid of two removable pegs. One peg is held in each hand and inserted as far up as possible, and the climber pulls up on them. Then, with one peg kept in place, he pulls himself up without using his legs or feet and inserts the other peg, and so on until the top is reached. If the climb is too arduous, practice may be allowed with three pegs and the feet.

Use 6" by 6" sanded timber 12' to 16' long for the pole. Bore $1\frac{1}{4}$ " holes for the pegs about 7" apart, starting about 4' from the ground line. They should be on all four sides, and it may make climbing a little easier if corresponding holes are on the same level. Bevel the corners and embed the pole in cement or brace it under the ground with crosspieces on all four sides. Make the pegs of dowel sanded smooth to fit closely but freely in the holes.

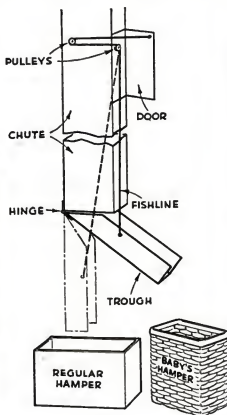
Pulley on Chute Door Separates Soiled Clothes in Basement

SEPARATELY washed clothing, such as children's wear and women's underthings, are sorted automatically by this chute as they are sent down to the laundry. A pulley arrangement connecting the door upstairs to a hinged trough at the bottom does the trick. Hampers are placed on the laundry floor so clothing will slide into one when the trough is pulled up and into the other when it hangs straight down. All that is necessary in depositing the

soiled clothing upstairs is to hold the door open for that intended for the first hamper and to close it quickly for the other. The device obviates the need of keeping the two hampers upstairs.—WILLIAM B. SCHWAB.



Soiled laundry goes to the hamper for which it is intended by means of the hinged trough.



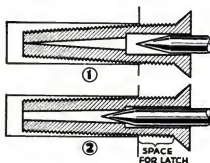
Through a pulley arrangement inside the chute, the trough is raised or lowered by the door upstairs.



Kept open, the door holds the trough up; closed, it drops the trough down.

Brad Spreads Split Screw to Clinch It in Blind Rivet Hole

IN ORDER to fasten a catch on an oven door, a method had to be devised for clinching a rivet or bolt from the outside because the inner end was inaccessible. A brass machine screw was chosen for the job, drilled lengthwise, and split on the threaded end. The screw was then inserted in the door, and a steel brad was driven into its hole to spread the two threaded parts. Sufficient pressure is exerted by the spread to hold the screw in place, and the threads provide extra friction.—RALPH A. VON KAMECKE.



Disks of Screening Stacked on Bolt Form Rotary Wire Brush



FOR removing grease and rust and doing other jobs, a rotary wire brush can be made of a dozen 3" disks cut from old copper screening. Press the disks on a bolt between washers and lock with two nuts. Chuck in an electric drill.—E. D. MERWIN.

HOME EXPERIMENTS



Seen in a Candle Flame

Nearly 90 years ago, Michael Faraday set about taking a candle flame apart to find out what it was made of. Then in a famous series of lectures at the British Royal Institution, he proved this common flame was actually a miniature laboratory in which could be found many fascinating transformations of chemistry.

It would require hours to perform all the experiments Faraday suggested, but you can easily demonstrate some of the most interesting in a few minutes.



WITH merely a sheet of paper you can investigate the physical structure of a candle flame and find out how its heat is distributed. Hold the paper horizontally and thrust it quickly about $\frac{1}{4}$ " above the wick with as little disturbance of the flame as possible. Remove it as soon as the top begins to scorch. If you are quick enough, the flame will form a distinct ring with an unscorched center, as in Fig. 1. Thus it appears to be hollow and fairly cool just above the wick.

By inserting the paper at successively higher levels, you will finally find a point where the sides of the flame merge. This is its hottest spot.

What takes place in the cool, hollow zone? There the liquid paraffin that climbs up the candle wick is broken down by the surrounding heat into gases—ethylene, carbon monoxide, acetylene, and hydrogen. This is the "cracking chamber" of a miniature gas plant.

It would be difficult to identify these gases with simple equipment, but you can prove they are combustible with a glass tube that





has been drawn to a jet at one end. Support the other end in the center of the flame, as shown in Fig. 2, and light the jet.

Ordinarily these gases enter the luminous part of the candle flame where the carbon monoxide and hydrogen are consumed and the acetylene and ethylene are further changed to carbon and hydrogen. In an efficient flame, this hydrogen and carbon are completely burned in an outer nonluminous part. When hydrogen burns, it is united with oxygen, and water is the final product. A chilled spoon held just above the tip of the flame will first be fogged, and then drops of water may form, as in Fig. 3.

To complete cracking the paraffin oil and burning the cracked products, the flame must supply sufficient heat. If it is robbed of heat, as by the window screening in Fig. 4, part of the fuel is wasted as smoke and soot consisting of white paraffin-oil vapor and black particles of carbon.

That the flame produces carbon can be shown by holding a cool plate just inside the luminous part of the flame, as in Fig. 5.

The greasy, black deposit is finely divided carbon called lampblack.

When a candle burns quietly, this carbon is first heated to incandescence, giving luminosity to the flame, and then is consumed. To show that the lampblack can be burned, form a blowpipe by closing one end of a drinking straw and making a pinhole $\frac{1}{8}$ " from the closed end. Dip the straw in water to keep it from burning, hold it close to the upper end of the candle wick, and blow toward the carbon on the plate, as shown in Fig. 6. The extra air should increase the heat so greatly that the carbon will be burned away. Use an old plate.

Without its incandescent carbon particles, the candle flame would give no more light than an efficient gas flame of a Fisher or Bunsen burner. Although the gas flame is many times hotter, it will light a surface no more than at the right in Fig. 7. But insert a short length of nickel chromium wire from an old electric-heater element into the gas flame, and light will be produced, as in Fig. 8, by the incandescent wire.





Incompletely seasoned timber warps easily. Set up for building, the stem of this backbone assembly is checked with a straightedge. It has a $\frac{1}{2}$ " warp.

BUILD True to SAIL True

The bigger your boat, the more important are sound shoring and constant checking as you build to keep out construction errors.

By ELON JESSUP

MANY amateur builders underrate the importance of rigid bracing and shoring when laying the keel and setting up the molds of a boat. After the planking is firmly in place, all worries on this score are over, for the boat will have become a solid entity capable of taking care of herself. But while still a skeleton, she will move out of true if permitted the slightest leeway, and a serious error may be built in.

When a frame refuses to remain true, the cause can usually be laid to the inevitable wrenches and strains of building. But another factor to guard against when seasoned lumber is not available is the natural warping of green wood. Most amateurs work on a boat periodically during spare time. This can give poorly seasoned lumber an opportunity to warp out of shape unless rigid pressure is exerted to prevent it.

The stem of the boat shown under construction in the accompanying photos had been cut from green lumber and was therefore obviously suspect. After being set up permanently in position, it was checked for trueness with a straightedge and spirit level and found to have warped a full $\frac{1}{2}$ ". But for prompt correction and additional shoring to keep it true, the boat would always have been lopsided to some extent and forever tending to turn to one side.

How best to go about setting up and shoring will depend both on the facilities at hand and on whether it seems preferable to build the boat right-side up or upside down. In either case, of prime importance is bracing so firm that the structure cannot possibly wobble regardless of strain.

The boat shown is a V-bottom 18-footer, too heavy to be built bottom up. A great disadvantage of building right-side up is the difficulty of getting at the bottom, but this can be overcome to some extent if the keel is set several feet above the floor. Another possibility shown is the tilting of the boat on her side after the sides have been planked and the shoring above released. If a boat isn't too heavy, she can be turned completely over.

Build inside if possible. Besides protecting the unpainted lumber from the ravages of rain and sun, you will have a floor and a roof as invaluable building aids. Outdoors a builder can't always find backing for his braces and shores.

The building conditions shown in the photos might be called close to ideal. Underneath is a level wood floor to which braces

and shores can be firmly nailed. Overhead runs not only an adequate strong beam, but a rigid steel I-beam as well. With proper shoring, it is difficult to see how the backbone of the boat could possibly move. In addition there is ample elbow room.

To begin, snap a chalk line on the floor directly under a strong beam to represent the centerline of the boat. Undersupports are then placed in reference to this line. For a small boat, sawhorses will often do; for a larger one, the supports may be heavy crossbearers, two-by-four uprights, or a combination of the two. In the case illustrated, heavy bearers were placed forward and aft with uprights between them.

Lay one of the heavy bearers across the centerline directly under the mold that will

come farthest forward and lay the other under the mold farthest aft. Select bearers with a view to having the rabbet line of the keel even, or build them up to proper height. Then rest the assembled stem and keel on the bearers and check with a spirit level. When level, clamp the keel between small blocks nailed to the bearers.

Next, measure the distance from the top-side of the keel assembly to the underside of the beam overhead, and cut two two-by-four uprights accordingly, sawing for a tight fit. Place one directly over the forward bearer and the other over the one aft, and check again with the spirit level. Then measure from the floor to the bottom of the keel, cut short two-by-four uprights to suit, and get them in place, each one directly under where

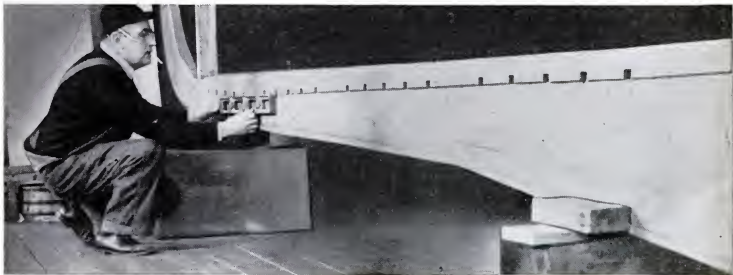


Time and pressure true up a warped stem. Two two-by-fours are braced against it, one above the other, pressing in opposite directions.



Additional braces are forced in below the first pair. Diagonals must be beveled to fit the keel just below the rabbet line and to fit solidly on the floor.

Checking for keel levelness with a spirit level held against the rabbet line. If the keel is found out of level, one or more of the crossbearers under it will have to be raised or lowered to proper height.





At left, a two-by-four is forced in between the topside of the keel and the overhead beam. After it is checked with a spirit level, it is toenailed in place. More diagonals are fitted in as above. The best system is to alternate from one side to the other to avoid one-sided pressure.



Unless double bracing is provided at the skeg and keel, these parts can easily be pressed out of line during building.



Here the molds are being put in. Uprights have been forced in above and below the keel at each station, and the molds are accurately leveled and screwed to the uprights.

a mold will be set in to take the planking.

Cut an equal number of uprights for the topside, measuring each to reach from the keel to the overhead beam. Line each up vertically over an undersupport, apply the level freely, and after each standing has been shown true, nail the ends. If the beam is steel, as in the photos, horizontal stringers will have to straddle it to provide nailing surface. You can also shore to the roof or to whatever wood backing is convenient. The point is to make each upright so firm it can't possibly be budged.

Now, saw out a series of two-by-four

diagonal braces with the upper ends beveled to fit the keel just below the rabbet line and the lower ends to fit solidly on the floor. Nail them to the floor and the keel along both sides, but don't drive nails in the keel all the way home. There may be need for readjustment later.

The molds can then be placed in position along the keel. In the type of construction shown in the photos, the molds have been built as master frames, each to become a permanent part of the boat. Often they may simply be rough lumber that will be discarded later. In either case, they must be

carefully fitted and leveled, and each must be fastened to an upright with screws. You can't be too careful in checking and re-checking. Hold the spirit level against the keel, against the uprights, and against the tie-piece of the molds. If any error is discovered, don't proceed further with the bracing until it has been righted.

With the backbone of the boat solidly shored and braced, and with the molds fastened in and true, actual construction can begin. However, if you feel that more brac-

ing and shoring might prove helpful, don't hesitate to get it in. In some cases a single frame may need four or five braces. Also, as you proceed with construction, shoring from the floor to the turn of the bilge may become necessary.

Much will depend upon the type and size of the boat. But it's a good general rule that the more shoring you use, the less chance the hull of your boat will deviate from clean, fair lines. Extra care at this stage means an appreciably better boat in the end. **END**



Checking and rechecking with the level one of the utmost importance after each step. Here a slight error is being corrected with an extra brace.



When the keel has finally been braced so it can't possibly be budged and all molds have been put in, leveled, and fastened, actual construction begins.

One of the disadvantages of building a boat right-side up is the difficulty of getting at the bottom, but this is offset if the boat can be tilted on one side. Then laying of the planking will be fairly easy.

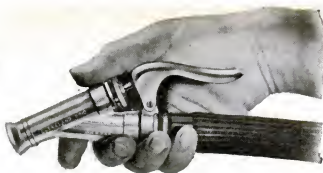
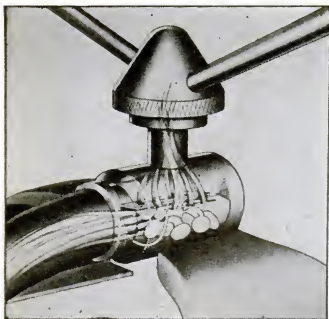


Garden Gadgets

PATTERN SPRINKLERS. Several manufacturers have put on the market lawn sprinklers designed to irrigate noncircular areas. Below is the Watergyro Sprinkler, made by Manning Products, of Birmingham, Mich. It can be set to water circular, square, triangular, rectangular, or oval areas by adjusting a flexible metal track along which a wheeled control lever travels.

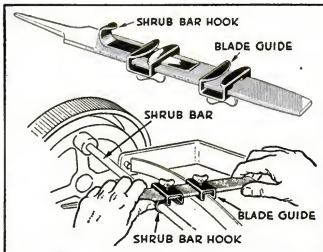


SPRAYER FERTILIZES SOIL. Concentrated fertilizer tablets placed in the head of a lawn sprinkler produced by the Rieger Manufacturing Co., of Miamisburg, Ohio, are dissolved by the water and sprayed over the area covered by the sprinkler.




HAND HOSE NOZZLE. With a lever-operated hose nozzle made by Kay Products, of Cleveland, you can control the stream from fine mist to full force simply by hand pressure.

LAWN-MOWER SHARPENER. Clamped with setscrews to a standard 10" flat mill file, two small metal guides manufactured by T. W. Slingsby, Inc., of Saybrook, Conn., are said to make it possible to sharpen a lawn mower in a jiffy. One guide hooks over the shrub bar of the lawn mower and the other rests on the blade to keep the file constantly at the proper angle as it is drawn toward you along the length of the blade. The sharpening outfit, complete with file, retails for about \$1.25.



BIG BERTHA DUST GUN. The 36" long dust gun below was created by the Sherwin-Williams Company to handle a new insecticide said to be effective against at least 27 common insect pests and plant diseases. It holds 2 lb. of insecticide.





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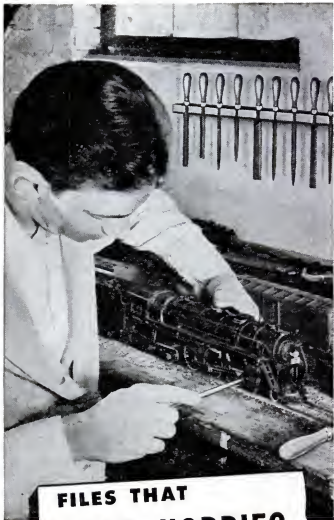
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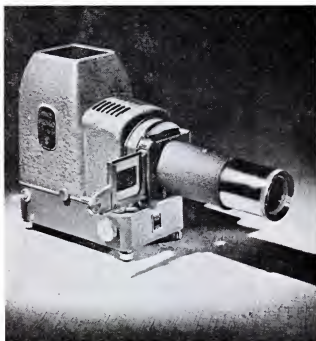
FILES

FOR EVERY PURPOSE



Engine Uses Fuel Guides

BECAUSE the incoming fuel charge is controlled by angled guide vanes in the intake ports, instead of piston-top deflectors, detonation from hot spots on the piston is said to be sharply reduced in the McCulloch Model 1200D single-cylinder, two-cycle, air-cooled gasoline engine. The new easy-starting engine weighs only 24 pounds and develops 2.5 horsepower at 2,500 r.p.m.



Projector Protects Slides

THE Filmo Duo-Master projector for two-by-two-inch slides has a heat-absorbing glass filter and a slotted slide carrier, which protect slides against damage resulting from high temperatures.

Dependable

CHAMPION

AMERICA'S FAVORITE SPARK PLUG



When the Navy's Patrol bomber "Truculent Turtle" set a world's non-stop long distance record in a flight of over 11,000 miles, it was equipped with Champion Spark Plugs. This flight from Perth, Australia, to Columbus, Ohio, provided another exceptional example of the outstanding dependability of Champion Spark Plugs. The name Champion and the word "dependable" are synonymous, a fact that has made it America's Favorite Spark Plug — for every engine. Champion Spark Plug Company, Toledo 1, Ohio.

FOLLOW THE EXPERTS

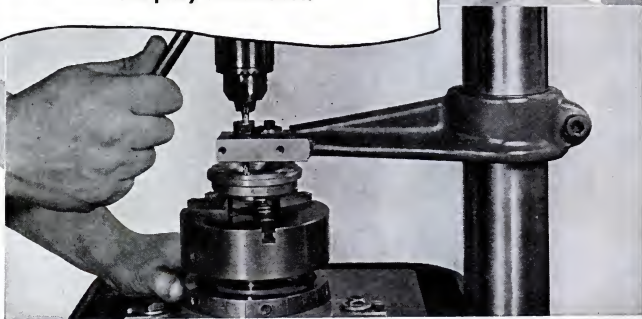
DEMAND DEPENDABLE

CHAMPIONS FOR YOUR CAR

Listen to the CHAMPION ROLL CALL, Harry Wismer's fast sportscast every Friday night, 9:55 EST over the ABC network

MAY
1947 227

**To Help You
Simplify Production**

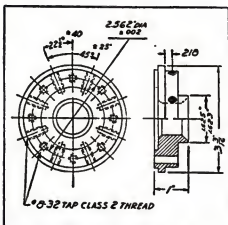


The new Aetna Adapter, of aluminum alloy, fits the columns of most small drill presses—assures accurate milling and deep hole drilling—without a drill jig. It firmly and accurately holds interchangeable drill bushings close to work.

Precision Alignment is accomplished through an eccentric aligning bushing, which once set needs no further adjustment. Filler bushings cover the entire bushing range up to 1½". Stops to locate the piece to be drilled, are attached to the press table or directly to the adapter. Milling chatter is avoided. Chip interference is eliminated. Overlapping holes can be drilled without punch marks, or indication of run-out, with drills as small as 1/32" diameter. ¼" holes can be drilled more than 6" deep with as little as .006" drift.

Accuracy in work is achieved best by alert workers. That's why many plant owners make chewing gum available to all. The chewing action helps relieve monotony—helps keep workers alert, aiding them to do a better job with more ease and safety. And they can chew Wrigley's Spearmint Gum right on the job—even when hands are busy.

You can get complete information from
Aetna Mfg. Co., 250 Chicago Ave., Oak Park, Ill.



Example of piece drilled with Actna Adapter



AB-63

Clean up your Horsepower

New smoothness, zip and power—that's what a Casite motor clean-up does for your car. Casite frees sticking valves and rings . . . retards formation of sludge and gum . . . speeds lubrication.

and keep it clean...

Everyone knows a clean motor runs better and lasts longer, so use Casite regularly—a pint through the air intake every three months and a pint in the crankcase every oil change.

the Guaranteed Way!

Double-Your-Money-Back if your car doesn't run better and smoother with Casite. And Casite makes this famous guarantee no matter what kind of motor oil you're using. Service stations, garages and car dealers everywhere sell Casite. The Casite Corporation, Hastings, Michigan, and the Casite Division, Hastings Ltd., Toronto.

CLEANS MOTORS
KEEPS MOTORS CLEAN



65¢ A PINT
75¢ IN CANADA

MAY
1,947 229

USE AC's FOR
**UTMOST
RELIABILITY**

"The mail must go through"—and does, with the help of today's AC's in thousands of mail cars and trucks. You can enjoy utmost reliability in spark plug performance by having your spark plugs checked to be sure they are right for today's driving and fuels.



Look for this sign



Spark Plugs cleaned and adjusted "By the AC Method" may save as much gas as 1 gallon in 10



**AC
SPARK PLUGS**

AC SPARK PLUG DIVISION • GENERAL MOTORS CORPORATION
230 POPULAR SCIENCE



Meters "Ayes" and "Nays"

Mass decisions of up to 120 persons can be secretly compiled by General Electric's new electric opinion meter. Individuals set the hands of units at their seats at a number that represents their judgment. These settings are registered on a central indicator, where a large sweep hand moves clockwise from zero around to the number that sums up the opinion of the majority.



Massage Unit Supplies Heat

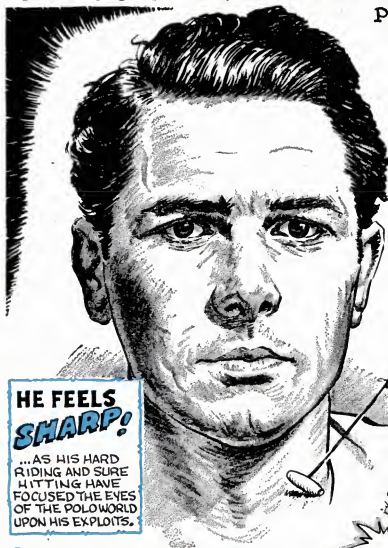
With the new Roll a Ray it is possible to have a rubdown and an infrared heat treatment at the same time. Its plastic case houses an infrared lamp and two rubber massaging rollers.

CLASS ALWAYS TELLS by FRANK WILLIAMS

POLO'S LATEST SENSATION

PETER **PERKINS**

...AT 26, YOUNGEST PLAYER EVER NAMED TO REPRESENT THE U.S. IN INTERNATIONAL MATCHES!



HE FEELS SHARP!

...AS HIS HARD RIDING AND SURE HITTING HAVE FOCUSED THE EYES OF THE POLO WORLD UPON HIS EXPLOITS.

look **SHARP**
feel **SHARP**
be **SHARP**

use
Gillette
Blue Blades
with the **SHARPEST** edges
ever honed!

● You look sharp for you enjoy the swellest shaves ever. You feel sharp because they're refreshing and give you a lift. You are sharp for you get far more shaves per blade and save money. Ask for Gillette Blue Blades.



5 for 25¢

ENJOY BOXING FRIDAYS OVER ABC NETWORK.

GILLETTE'S CAVALCADE OF SPORTS ALSO AIRS THE KENTUCKY DERBY, MAY 3, AND OTHER CLASSICS YEAR 'ROUND.



HE LOOKS SHARP!

...THE CALIFORNIAN'S BRILLIANT Mallet PLAY SHOWS NO EVIDENCE THAT HE WENT THROUGH THE BATAAN DEATH MARCH AND THREE AND A HALF YEARS IN JAP LABOR CAMPS.



HE IS SHARP!

...PETE ENJOYS THE CLEANEST, SMOOTHEST SHAVES A FELLOW CAN HAVE, FOR HE ALWAYS USES **GILLETTE BLUE BLADES** WITH THE SHARPEST EDGES EVER HONED. YES, AND HE SAVES MONEY, TOO, FOR **DOUBLE EDGES MEAN DOUBLE ECONOMY!**

Gillette Safety Razor Company, Boston 6, Mass.

Copyright, 1941, by Gillette Safety Razor Company

MAY 1947 231

Planes, Pets, Puppets



all "duck-soup" with X-acto!

Experts prefer X-acto because it's always sharp, always ready, with the just-right blade and tool for every job. Amateurs find X-acto's safer, surer — helps them turn out better jobs, makes them *feel* like experts. Try X-acto for your hobby!



Expert Whittler and Wood-Carver Leroy Pynn, Jr. of Wisconsin says "X-acto's variety of shapes and sizes means a lot to a constant whittler . . . and it stands up just as well with hard as with soft wood."



Grand Championship Trophy winner at Toronto's Eaton Contest, R. Bruce Lester finds X-acto "helps turn out better models . . . best of all the knives I've used in building models for 20 years!"



Puppetry Instructor Bernard H. Paul at Maryland Institute of Art recommends X-acto Knives "for detail work on heads, as well as for heavier body carving . . . and because they're so easily handled even for a beginner."

X-acto*



HANDICRAFT KNIVES & TOOLS

Singly or in sets, 50c to \$50.

At hobby, gift and hardware shops

X-acto Crescent Products Co., Inc., 440 Fourth Av., N. Y. 16

In Canada: Handicraft Tools, Ltd., Hermant Bldg., Toronto

Prices slightly higher in Canada

*Reg. U. S. Pat. Off.

NEW!
only
\$3



THE PERFECT TOOL

for wood, linoleum, plastics. No. 77 X-acto Woodcarving Set: 6 chisel and gouge blades; 4 assorted regular blades; 2 three-inch blades. Special handle takes all blades.

PALS

AUTOMATIC HEAT
AND
HONEYWELL CONTROLS



FOR more than 60 years, the leading manufacturers of heating equipment and Minneapolis-Honeywell have worked together to raise the standard of home heating comfort. The healthful, even temperature maintained by Honeywell is enjoyed in millions of homes, both large and small.

For your own greater comfort, make sure that your heating plant is fully automatic with Honeywell controls.

If you want the last word in heating comfort, install Moduflow, the remarkable new Honeywell control system. Ask your heating dealer about the new developments in automatic heating equipment — and Moduflow.



HONEYWELL

Automatic
HEATING CONTROLS

Minneapolis-Honeywell Regulator Company, Minneapolis 8, Minnesota . . . Canadian Plant: Toronto 12, Ontario.

MAY
1947 233



Ozonizer Shoos Room Odors

THE portable Refresh-Aire room ozonizer removes odors by ionizing oxygen with a Sylvania electronic ionization tube, much as lightning bolts freshen the air by creating ozone. The conditioner, which measures only 7½ by 5½ by 4½ inches, uses 10 watts on 110-volt, 60-cycle current.



Even Power for Projectors

IN AREAS where the power supply is fitful, the Victor Voltage Regulator for 16-mm. film projectors holds the power to a correct, uniform level. In so doing it lengthens the life of lamps, improves both the motion pictures and the sound and decreases usual replacement costs.

SO MANY THOUSANDS SAY:

"America's Great Fishing Motor"

Ask your experienced fishin' friends what outboard motor they recommend for sweetest performance, easiest handling and all around dependability. Such a big percentage of America's fishermen own Johnsons that we are sure of the answer you will get. Expert fishermen know outboards from experience. And there is no substitute for experience!

FREE HANDY CHART: Full details on all Johnson Sea-Horses. Write, JOHNSON MOTORS, 500 PERSHING ROAD, WAUKEGAN, ILLINOIS
Johnson Motors of Canada, Peterboro, Canada



FAMOUS FOR DEPENDABILITY

See your Johnson Dealer about delivery. Look for his name under "Outboard Motors" in your classified phone book.

JOHNSON SEA-HORSE

NEW EVEREADY

TRADE-MARK

FLASHLIGHT BATTERIES

*Now last 93%
longer!**

**Packs Enough Energy
for 3 400-lb. Bar Bell Lifts!**

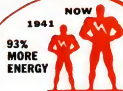
Can YOU raise 400 pounds 7 feet in the air? A few champion strong men can... But the energy of one tiny "Eveready" flashlight cell, properly expended, could perform this back-breaking feat 3 times! Think of this kind of energy when you buy flashlight cells... ask for "Eveready" batteries every time. Still 10¢ each.



● You've got a "pipe line to the powerhouse" when your flashlight contains these great new "Eveready" cells. For they give you nearly double the energy that pre-war "Eveready" batteries gave you. No wonder these are the largest-selling flashlight batteries in the world! No wonder it can be said, "Get 'Eveready' brand flashlight batteries... and you get the best!"

The registered trade-mark "Eveready" distinguishes products of
NATIONAL CARBON COMPANY, INC.
30 East 42nd Street, New York 17, N. Y.
Unit of Union Carbide and Carbon Corporation

UCC



* Nearly twice the electric energy. That's today's high-energy "Eveready" battery, as proved by the "Light Industrial Flashlight" test devised by the American Standards Assn.



High Energy
**MEANS BRIGHTER LIGHT,
LONGER LIFE**

Sweeping the Country



Speed Sweep

**THE BRUSH WITH
THE STEEL BACK**

Speed Sweep brushes are replacing old style brushes in thousands of factories, warehouses, and stores because they sweep faster, cleaner and easier. Speed Sweep brushes also outlast ordinary brushes 3 to 1. There is a Speed Sweep to meet every requirement. Write for styles, sizes and prices today.

Milwaukee Dustless Brush Co.,
530 North 22nd Street
Milwaukee 3, Wis.

Please send me complete information about Speed Sweep brushes.

Name _____

Address _____

City _____ State _____



**A WHOLE SHOP
FULL OF TOOLS
IN ONE!**

Use it for grinding, routing, drilling, sawing, polishing, carving, sanding and 9,994 other uses. Increases your skill and your scope. Precision-engineered, A.C.-D.C. More exclusive features than any other tool.

Exclusive
Safety
Fingergrip
for fine
detail work

\$2250

**COMPLETE WITH 36 ACCESSORIES
IN FITTED STEEL CASE**

Works **Wood, Metal,
Glass, Plastics**

**\$32.95 Value if
Purchased Separately**

CASCO ELECTRI-CRAFT TOOL KIT
CASCO PRODUCTS CORPORATION, BRIDGEPORT 2, CONN.

PLASTICS

PRACTICAL HOME-STUDY COURSE

One kit each month—12 month complete course

\$1.00 BRINGS FIRST LESSON

Refundable to students taking complete course



Full scale drawings in each kit. Basic through advanced techniques. Ideal course for homeworkshop hobbyists and those who want to supplement their incomes. Not designed to make you a plastics engineer but gives you a complete, practical knowledge of making small plastics projects such as cigarette boxes, bathroom fixtures, cocktail trays, coffee tables and many others. Send in your \$1.00 today for your first lesson.

KOSTO PLASTI-KITS

3263 M St. N. W., Washington 7, D. C.

IF GLUE WILL FIX IT

FRANKLIN LIQUID GLUE

will do it better, faster, easier!

Ready-to-use Franklin makes joints stronger than the wood itself. Saves time — no mixing, no heating. Banish unpleasant odors, avoid chilled joints with Franklin Liquid Hide Glue.

The FRANKLIN GLUE CO., COLUMBUS 15, O

AT YOUR HARDWARE DEALER





OWN A HARLEY-DAVIDSON

and make the entire country your vacation land

Enjoy the most thrilling vacation of your life this year—on a Harley-Davidson. It brings most of the country's historic places, natural wonders and famous fun spots within easy range. Go whenever you get the urge—stop where and when you choose—with no timetables to follow. What's more, motor-

cycling turns every evening, holiday or weekend into extra "vacation-time"—as you zoom along with other fun-loving riders on pleasure jaunts and club runs—or take in race-meets, hillclimbs and other thrill-packed motorcycling events. See your Harley-Davidson dealer NOW—and mail coupon today!

HARLEY-DAVIDSON *Motorcycles*

HARLEY-DAVIDSON MOTOR CO., Dept. P5, Milwaukee 1, Wisconsin

Please send at once free copy of 24-page "ENTHUSIAST" Magazine, filled with thrilling motorcycle action pictures and stories.

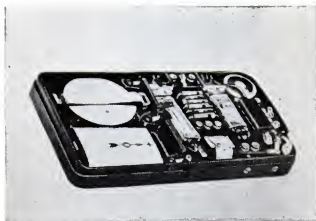
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State.....

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Pocket Hearing Aids Shrink

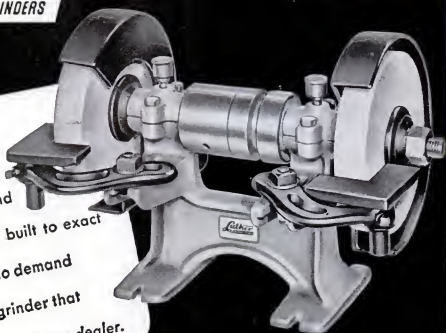
Using tiny tubes and batteries originally designed for the proximity fuse, the latest Acousticon hearing aid (above) combines power supply and amplifier in one container no larger than a cigarette case. Shorter than a fountain pen and almost as thin (top right), it weighs only 5½ ounces yet provides as much volume as the largest old-style aids. The tiny, ladderlike grids at right, shown against the skin pattern of a human hand, are part of the miniature tubes in a new Sonotone hearing device.



Luther POWER GRINDERS

HAND AND POWER GRINDERS

Like all Luther Grinders, the power grinder shown here is famous for high quality and rugged construction. It is built to exact specifications for those who demand fine tools. For the Luther grinder that fits your needs, see your hardware dealer.



LUTHER GRINDER & TOOL CO.
(Established 1896) Sheboygan, Wisconsin

Here's your "FOUR"—for more fun fishing

EVINRUDE

Zephyr

FOUR CYLINDERS

One top choice! . . . if you want the kind of motor that just naturally seems to do all things better! It's a pedigreed Evinrude "Four" for the smoothest, sweetest outboard power you've ever dreamed! It's an Evinrude "Four" for hair-trigger starting ease and sureness. It's an Evinrude "Four" for utmost flexibility, for thrilling responsiveness.

In the 5.4* horsepower Zephyr it's all yours . . . all the glorious performance of a "Four" packed into a motor of the most popular size for average service. Try it—ride with it—learn what 38 years of know-how have contributed to fine outboard performance!

See your Evinrude Dealer! Look for his name in your classified phone directory under "Outboard Motors". Evinrude Catalog FREE. Write today for catalog of the complete Evinrude line. Address, EVINRUDE MOTORS, 5533 N. 27th Street, Milwaukee 9, Wis.

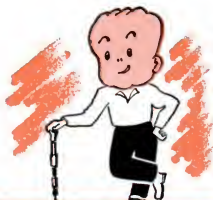
In Canada: Evinrude Motors,
Peterboro, Ontario.

*5.4 O.B.C. certified brake H.P.
at 4000 R. P. M.

FIRST IN OUTBOARDS

— 38TH YEAR

EVINRUDE



**Save Time
on Routine Jobs**

with an AUTOMATIC SCREW DRIVER

Whether it's light production assembling or a routine home workshop job, you can save a lot of time with a Millers Falls Automatic Screw Driver. This unique spiral ratchet tool can handle any screw driving job quicker and easier. By simply shifting the knurled control sleeve and the spiral lock nut, it can be used either as a regular rigid screw driver, a right or left hand ratchet, or as a complete automatic. Made with or without quick return.

Smooth, powerful action and tested dependability are built right into Millers Falls Automatic Screw Drivers. You can depend on them for long-lasting satisfaction. Ask to see one at your dealers today.

One thing in common—Quality

**MILLERS FALLS
TOOLS**

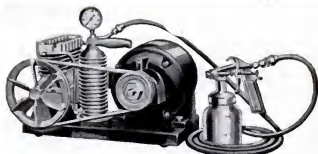
SINCE
1868

MILLERS FALLS COMPANY
GREENFIELD • MASSACHUSETTS



PRESSURE QUEEN

FOUR CYLINDER
PORTABLE AIR COMPRESSOR
SPRAY PAINTING OUTFIT



COMPACT • RUGGED • POWERFUL

The ideal air supply for home and farm workshop, machine shop, garage and contracting painter; for product finishing, inflating tires, painting automobiles, trucks, machinery, etc. Indispensable for building maintenance, interior and exterior. Handles any paint, insecticide or disinfectant.

This 4 cylinder compressor has drop forged crankshaft, stainless steel, heat treated valves; bronze bearings and positive forced feed lubrication. Maximum pressure 50-60 lbs., free from pulsation. Standard equipment includes the compressor mounted on steel base with carrying handle, belt, compressor pulley, air chamber, air gauge, 15-ft. hose, spray gun. Requires $\frac{1}{4}$ or $\frac{1}{2}$ h.p. motor or gas engine, not included.

If your dealer does not sell Pressure Queen write direct

THE CAMPBELL-HAUSFELD CO.

151 RAILROAD AVE.,

HARRISON, OHIO



MENDS

DISHES, TOYS, ETC.

It's clear, water-proof, flexible, durable.



DUPONT
REG. U. S. PAT. OFF.

DUCO CEMENT

REG. U. S. PAT. OFF.



Now Carmen-Bronson's Immense purchasing power and direct mill connections come to your rescue on hard-to-get plywood! Look at the galaxy of scarce items listed here! Look at the prices—so low by prevailing standards that almost every one of them represents a genuine bargain! Hurry with your order before our immense stock is sold out! Order direct from this ad today.

1/4" CABINET & PANELING BIRCH

Birch Plywood is one of the most popular and economical materials for cabinet and paneling work. 3-ply; good one side, sanded one side, Urea-resin glued.

24"x24" panel, ee....	.96
24"x48" panel, ee....	1.92
42"x48" panel, ee....	3.36
36"x60" panel, ee....	3.60
48"x48" panel, ee....	3.68
48"x84" panel, ee....	6.72

1/4" CABINET & PANELING BIRCH

Same type stock as above, but in standard 1/4" thickness. 3-ply; good one side, sanded one side, Urea-resin glued.

21"x24" panel, ee....	1.12
21"x48" panel, ee....	2.24
30"x48" panel, ee....	3.20
42"x48" panel, ee....	4.48

13/16" CABINET BIRCH

Heavy duty 13/16" thick stock for cabinet and paneling applications. Lumber core construction. 5-ply; good one side, sanded one side, Urea-resin glued. 13/16" thickness.

24"x24" panel, ee....	3.00
24"x48" panel, ee....	6.00
48"x48" panel, ee....	12.00
48"x96" panel, ee....	24.00

1/4" BASSWOOD

Basswood, because of its soft texture, is tremendously popular for jig-saw work and other applications. 1/4" thickness, unsanded but very smooth. Urea-resin glued, 3-ply, good one side.

24"x24" panel, ee....	1.04
24"x48" panel, ee....	2.08
36"x36" panel, ee....	2.25
36"x72" panel, ee....	4.50

3/16" UTILITY GUM

An economical panel that should find many profitable applications in your production plans. Panels are good one side, smooth one side, unsanded, 3-ply, Urea-resin glued.

48"x60" panel, ee....	3.50
49"x62" panel, ee....	4.20

1/4" PANELING GUM

Same general type of stock as above but in popular 1/4" thickness. 3-ply; good one side, sanded one side, Urea-resin glued.

24"x42" panel, ee....	1.75
48"x42" panel, ee....	3.50
48"x60" panel, ee....	4.95

3/16 MAPLE

An odd size lot of grade A panels which we are offering below mill cost. Panels are good one side, sanded both sides, 3-ply, Urea-resin glued.

24"x28" panel, ee....	1.20
-----------------------	------

1/4" WESTERN CEDAR

You have undoubtedly known Western Cedar from your pre-war experience with fine paneling plywoods. Now it's

available from C-B warehouse stocks. Unexcelled for paneling applications. 3-ply; good one side, sanded both, Urea-resin glued.

24"x24" panel, ee....	1.20
24"x48" panel, ee....	2.40
48"x48" panel, ee....	4.80
48"x72" panel, ee....	7.20
48"x96" panel, ee....	9.60

1/8" MAHOGANY

Mahogany has always been a great favorite among craftsmen and builders. For wall paneling, furniture, etc. 3-ply; good one side, sanded one side, Urea-resin glued.

24"x24" panel, ee....	1.60
24"x48" panel, ee....	3.20

1/4" MAHOGANY

Same general type Mahogany panels as above, but in popular 1/4" thickness. 3-ply; good one side, sanded one side, Urea-resin glued.

24"x24" panel, ee....	1.80
24"x48" panel, ee....	3.60
48"x48" panel, ee....	7.20

3/4" MAHOGANY

Here is an attractive heavy duty 7-ply panel for cabinet work, furniture, paneling, etc. 7-ply; good one side, sanded both, Urea-resin glued. 3/4" thickness.

24"x24" panel, ee....	3.20
24"x48" panel, ee....	6.40
48"x48" panel, ee....	12.80
48"x96" panel, ee....	25.60

1/2" WALNUT

Walnut stock that represents plywood at its most attractive best. 3-ply; good one side, sanded both, Urea-resin glued.

24"x24" panel, ee....	1.60
24"x48" panel, ee....	3.20
36"x36" panel, ee....	3.60
36"x72" panel, ee....	7.20

1/4" WALNUT

A fine attractive paneling stock in 1/4" thickness. 3-ply; good one side, sanded both, Urea-resin glued.

24"x24" panel, ee....	1.80
24"x48" panel, ee....	3.60

1/4" MARINE

Boat-builders from coast to coast will welcome this exciting news. Here is genuine Waterproof Mahogany Marine Plywood. Panels are 1/4" thick, Mahogany both sides, sanded both sides, good both sides. 3-ply construction, Urea-resin glued.

24"x24" panel, ee....	2.40
48"x22" panel, ee....	4.45
8"x14 1/2" panel, ee....	4.95
48"x48" panel, ee....	8.95
48"x96" panel, ee....	17.95
48"x144" panel, ee....	26.85
48"x166" panel, ee....	29.95

3/8" MARINE

MAHOGANY

Same general type of Marine Mahogany as above, but in rugged 3/8" thickness. Strictly waterproof panels. Mahogany both sides, sanded both sides. 5-ply construction.

24"x24" panel, ee....	3.40
24"x48" panel, ee....	6.80
48"x48" panel, ee....	13.60
48"x96" panel, ee....	27.20

3/4" PLASTIC SURFACED PLYWOOD

Another exciting C-B plywood panel, of special interest to boat builders. 7-ply waterproof stock. 3/4" thick each side surfaced with thin layer of plastic. Sanded and counter tops, paneling, etc. For boat stern boards, seats, etc.

24"x24" panel, ee....	2.70
24"x48" panel, ee....	5.30
48"x48" panel, ee....	10.55
48"x96" panel, ee....	20.80

1/4" MASONITE DISKS

Perfectly round disks of tempered Masonite (not Plywood) 1/4" thickness.

Masonite Disk, 8" dia., ee.....	.16
Masonite Disk, 10 1/2" dia., ee.....	.21

1/16" AIRCRAFT

MAHOGANY

Thin aircraft waterproof plywood panels. Unsanded but smooth 3-ply construction.

4"x24" panel, ee....	.18
10"x19" panel, ee....	.35
16"x20" panel, ee....	.65
10"x58" panel, ee....	1.05

1/16" AIRCRAFT GUM

Same type aircraft stock as above but in gum finish. 3-ply; waterproof.

5"x22" panel, ee....	.37
10"x58" panel, ee....	1.05

1/16" AIRCRAFT

SPRUCE

Same type stock as above but in Spruce finish.

20"x48" panel, ee....	1.60
-----------------------	------

1/16" AIRCRAFT BIRCH

Same type stock as above but in Birch finish. Good both sides, unsanded but

smooth. 3-ply waterproof, specially priced.

28"x40" panel, ee....	1.75
-----------------------	------

1/4" CEDAR EFFECT CARDBOARDS

These C-B cardboard panels are finished in an imaginative Cedar effect for building boxes and other projects.

18"x16" panel, ee....	.16
-----------------------	-----

3/4" BIRCH PANELS

An odd lot of small panels for lamp bases, etc. Good one side, sanded both. 5-ply, some select base.

2 1/2"x16" panel, ee....	.20
3 3/4"x14" panel, ee....	.22
4 1/2"x16" panel, ee....	.39
7 1/2"x16" panel, ee....	.44
8 1/2"x22" panel, ee....	.46
7 1/2"x22" panel, ee....	.70
13 1/2"x24" panel, ee....	.72
13 1/2"x14" panel, ee....	.77
14"x16" panel, ee....	1.05

1/8" LIGNOLITE

A Plastic panel of great durability for table tops and counter tops, paneling, etc. Polished black finish one side.

30"x36" panel, ee....	3.70
-----------------------	------

3/16" LIGNOLITE

Same type in Plastic panel as above but in 1/16" polished black finish one side.

30"x36" panel, ee....	5.40
-----------------------	------

3/4" GUM

Small narrow panels for a variety of craft uses. 3-ply; good one side, sanded both, Urea-resin glued.

4"x28" panel, ee....	.25
----------------------	-----

3/16" CABINET BIRCH

Small cabinet panels. Good one side, sanded one side, 3-ply.

15"x16" panel, ee....	.40
-----------------------	-----

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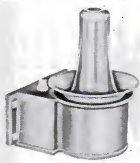
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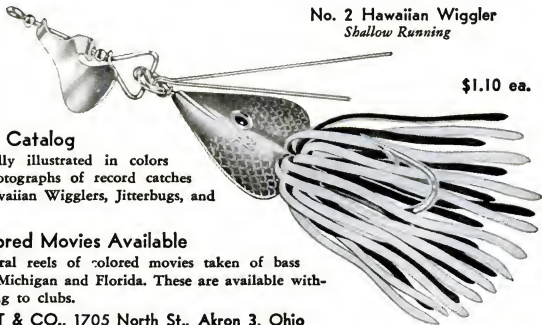
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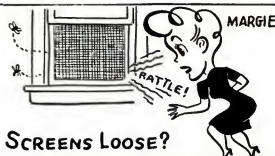
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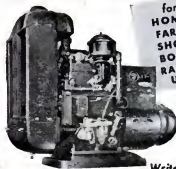
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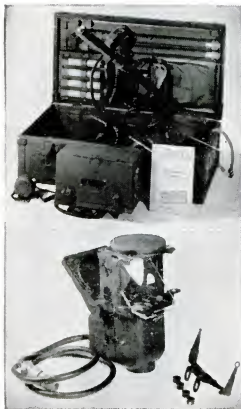
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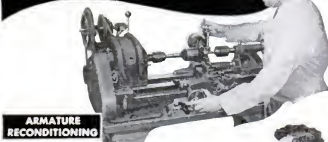
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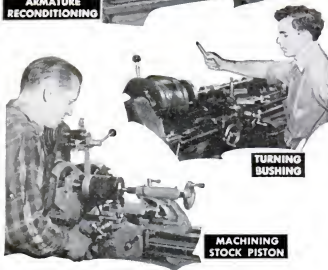
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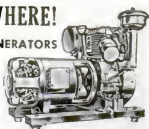
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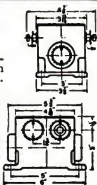
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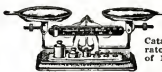
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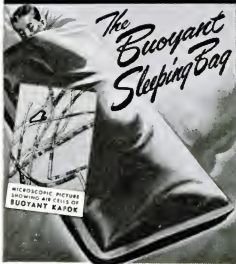
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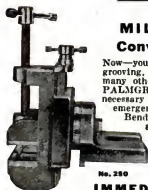
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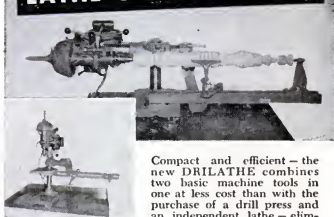
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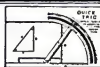
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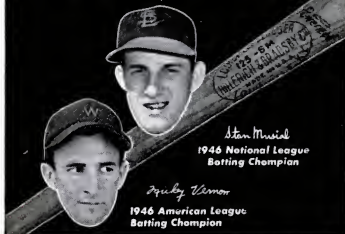
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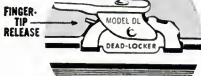
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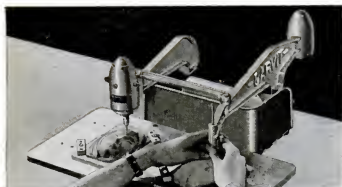
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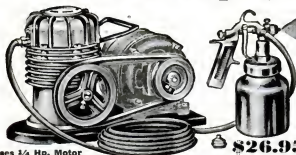
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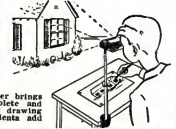
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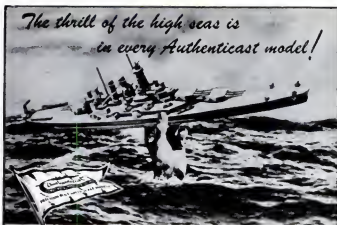
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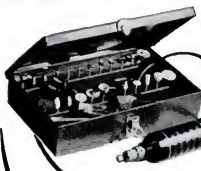
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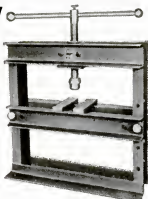
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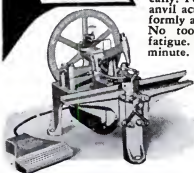
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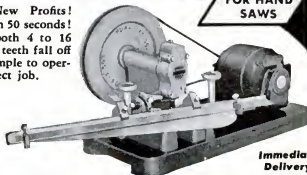
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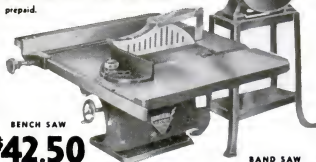
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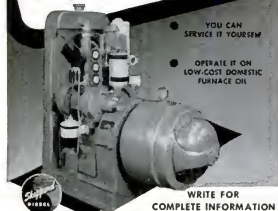
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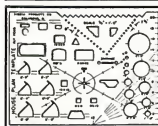
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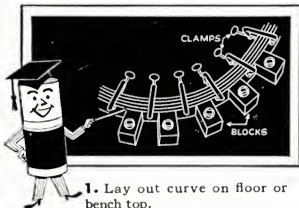
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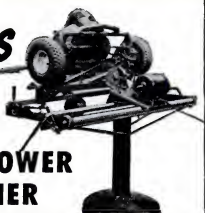
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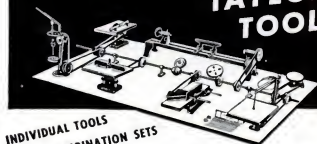
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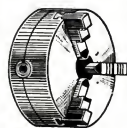
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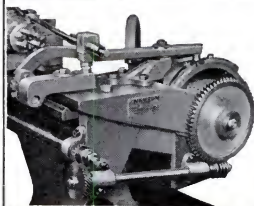
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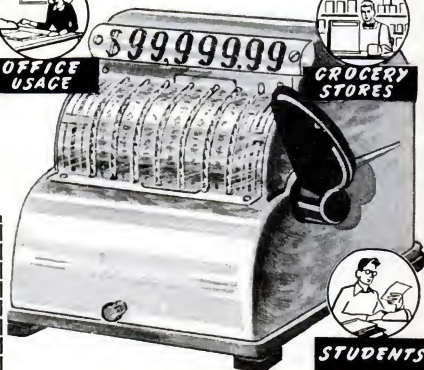
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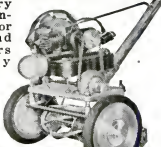
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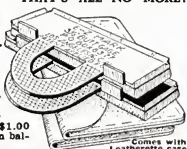
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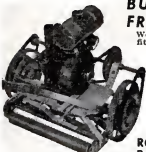
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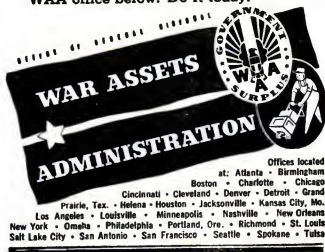
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TO:

Reader

FROM:

Editor

Do You Still Want to Fly to the Moon?

SO MANY readers wrote for more information about "How You'll Fly to the Moon" (PSM, Mar. '47, p. 71) that space travel would seem to be their chief interest. For those who like to figure things out themselves, here are some basic rocket facts.

A number of inquiries involved the speed a rocket needs before it will leave the earth and never return—the "escape velocity." Escape velocity can be computed from Sir Isaac Newton's law of gravitation (any two bodies attract one another with a force proportional to the product of their masses divided by the square of their separation), and turns out to be about 25,000 m.p.h. *at the earth's surface*. Because Newton's law depends inversely on the separation squared, the force of attraction and the escape velocity decrease as distance from the earth increases. The escape velocity at any altitude can be calculated from the following formula* given by Dr. Robert H. Goddard:

$$V_e = V_0 \times \sqrt{\frac{R}{R+H}}$$

where V_e = escape velocity at any altitude, V_0 = escape velocity at the earth's surface, R = radius of the earth (4,000 miles), and H = altitude.

Obviously, it would be necessary to delay reaching the escape velocity while the rocket gathered speed slowly, meantime traveling some distance from the earth—otherwise the passengers would be crushed to death by the sudden acceleration. The exact escape velocity, then, will depend on how far your rocket travels while it picks up speed—which, in turn, depends on the rate with which it picks up speed, or acceleration. An acceleration five times that normally caused by gravity (5G, or nearly 400,000 m.p.h. increase every hour) is probably safe for human be-

*Be careful to use the same units throughout any one formula. If velocity is expressed in miles per hour, distance must be in miles, time in hours.

ings; pilots of fast fighter planes have withstood even more.

Having settled on the acceleration your rocket will use, you can compute how far it must travel before it reaches any given speed by using two more of Sir Isaac's formulas:

$$H = \frac{1}{2} A \times T^2 \quad V = A \times T$$

where H = altitude or distance, A = acceleration, T = time, and V = velocity of the rocket.

These equations do not take into account air resistance, causing some error. The difference will not be very great, however, since the rocket travels through air for only the first few hundred miles of the trip. In addition, other calculations show that air resistance becomes much less important for large rockets.

After reaching escape velocity, the rocket will coast toward the moon. At a midway point (closer to the moon than the earth) the gravitation of the moon would begin to make itself felt, accelerating the rocket to the moon. The crew would then turn the space ship around and land stern first, using the propelling rocket tubes as brakes.

During the entire trip, the rocket would never leave the orbit of the earth—it would move around the sun with the earth, just as the moon does. To travel to another planet, a space ship must forsake the earth's orbit and establish its own path around the sun, choosing one that will almost cross the orbit of its destination. This coasting method of travel would require very careful navigation and would take a long time—146 days to Venus, for example—but seems to be the only one possible without using huge amounts of fuel.

A trip beyond the solar system to another part of the Milky Way is even more difficult; tremendous speed would be needed not only to escape from the sun's gravitation, but also to cover the vast distance before the crew died of old age. The nearest star after our own sun is almost 25 trillion miles away.

Strangely enough, no reader asked about the possible effect of the Einstein theory on the high velocities of space travel. Would the rocket ship gain weight through the conversion of speed energy into mass—sort of an atomic bomb working backwards? It has been worked out by a European physicist, J. Ackeret. His reassuring answer: for the speeds we'll use in interplanetary travel: no.

Martin Nam

This One



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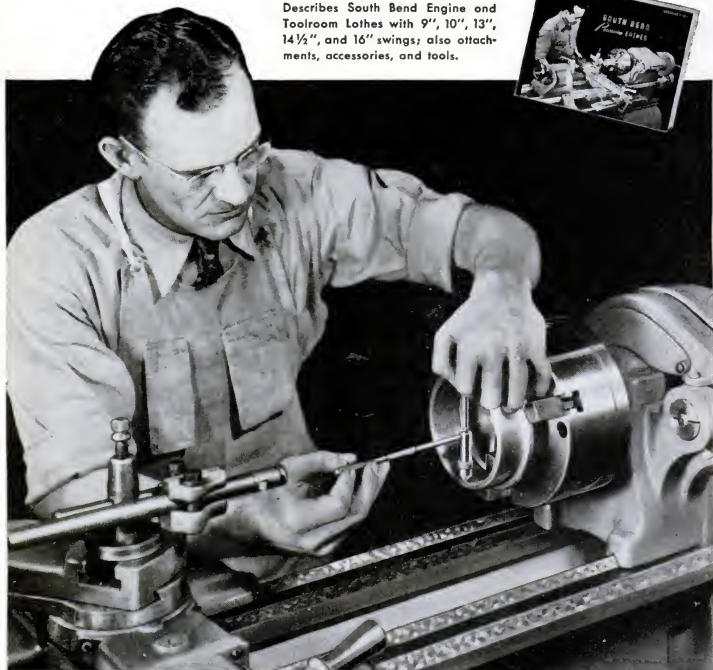
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